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BIRD RECORDS FROM THE VIRGIN ISLANDS

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INTRODUCTION

This paper gives the results of several short ornithological excursions which the author made to certain of the British and American Virgin Islands. During these trips the three American Virgin Islands of St. Croix, St. Thomas and St. Jan were visited, and also three of the British islands, namely, Tortola, Salt Island, and Virgin Gorda. A brief description of each of the islands visited may be in order.

DESCRIPTION OF THE ISLANDS

St. Croix is the largest of the Virgin Islands, and occupies a somewhat isolated position considerably south of the other islands of the group. It is twenty-one miles long and five miles wide at its widest point. The island is much flatter than most of the Virgin Islands and much of the land is under cultivation. The land which is not cultivated is largely covered with a dry, brushy type of vegetation which is very prevalent throughout the islands under discussion. There is one good sized hill, Mount Eagle, which reaches a height of 1165 feet. On this hill, and near it at a place called Prosperity, there is still some forest growth which has not been destroyed. Along the coastal region of St. Croix there are a number of salt water lagoons and mangrove swamps which produce the most favorable conditions for shorebirds that I found in any of the islands visited. The largest of these lagoons is Krausse's Lagoon, on the south side of the island. There are no fresh water ponds or swamps on the island. The eastern end of the island is wild and brushy. I arrived on St. Croix on the evening of December 24, 1926, and stayed there until the morning of January 3, 1927.

St. Thomas is the westernmost of the larger islands of the Virgin group. It is twelve miles in length and averages three or four miles in width. It is almost entirely hilly with very little level land. The

highest hill is West Mountain, which reaches a height of 1,550 feet. Only a small proportion of the land is under cultivation, and most of it is covered with a dry brushy type of vegetation. Along the coast there are a few indentations where some small mangrove-bordered lagoons exist. Between the only town on the island and its docks there is a cattail swamp perhaps an acre in extent, which is the only fresh water swamp on the island of which I am aware. The time which I spent in St. Thomas was very much broken up consisting mostly of short periods spent there while waiting for transportation to other islands. The following is a list of the days which I spent on St. Thomas: December 24, 1926; January 3–5 and 8–9, and December 17, and 30–31, 1927; January 1 and December 22–23, 1928; and January 3–5, 1929.

St. Jan lies directly east of St. Thomas. It is about eight miles long, and has a very irregular shoreline. It is almost entirely hilly, and has practically no land under cultivation. The highest land is Bordeaux Mountain, which attains an elevation of 1,277 feet. Most of the land on the island is covered with dry brushy vegetation, but on the higher hills larger trees and a less xerophytic type of vegetation are found. Like the British islands which I visited, St. Jan has no roads for wheeled vehicles. I spent two and a half days on St. Jan, from January 6 to 8, 1927.

Tortola is the most important and westernmost of the British Virgin Islands. It lies slightly north and east of St. Jan. It is ten miles long and about three and a half miles wide at its widest point. Its surface is almost entirely hilly, though at places near the coast there are small patches of level land, most of which are under cultivation. Its hills are the highest and most rugged of any in the Virgin Islands. One peak (Mount Sage) reaches a height of 1,780 feet. In some of the stream valleys on the higher hills the most humid type of vegetation which I have seen anywhere in the Virgin Islands can be found; in fact it is practically the only place where fresh water streams which never dry up can be found. Along the coast there are a number of mangrove swamps, but I found no fresh water swamps on the island. I spent the period from December 24, 1928 to January 3, 1929 on Tortola, with the exception of the two days of December 29 and January 1, on which I visited neighboring islands.

Salt Island is a small island directly south of the eastern end of Tortola, lying between Peter Island and Cooper Island. It is an irregular shaped island somewhat over a mile in length, and about the same distance in its greatest width. It is mostly hilly. A hill

in the northeast corner of the island is particularly rugged and nearly inaccesible, although it is only about 700 feet in height. South of this hill there are two little level valleys, one of which is occupied by saltponds for the production of salt by the evaporation of sea water. The other is used as grazing land. In the center of the latter valley is a small mudhole which is the nearest approach to a fresh water swamp on the island. The eastern shore of the island slopes off very gradually, leaving extensive shallows. There are some small areas of mangroves on this side of the island. The majority of the island is covered with the brushy xerophytic vegetation so characteristic of the Virgin Islands. I spent only one day (December 29, 1928) on Salt Island, but the island is so small that on that day I covered practically every bit of the island, despite the difficulties and even dangers of traversing certain parts of it (notably the cliffs which one has to negotiate in rounding the hill on the northeast part of the island).

Virgin Gorda, (known to mariners as Spanish Town), is a long, narrow island, and is the easternmost of the group of islands with which we are dealing. It is about ten miles long, but not much over a mile wide in most parts. In reality it consists of two islands joined together, a northern mountainous part culminating in a hill (Virgin Peak, 1,370 feet high), and a low, nearly flat southern part.

The southern part is strewn with large boulders which give it an aspect entirely different from that of any of the other islands of the Virgin group. Back of the beach on the western shore is an extensive brackish water, mangrove bordered lagoon where many ducks and other waterfowl can be found. Under the loose bark of dead mangroves bordering this lagoon I took six examples of *Bufo turpis*, a toad known only from Virgin Gorda, and previously known only from the type specimen taken in 1915 by Mr. J. L. Peters. I spent only one day (January 1, 1929) on Virgin Gorda, so time did not permit me to visit the entire island. Accordingly I confined my attentions to the southern part of the island, making only a short trip at the end of the day into the edge of the mountainous part.

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During the course of my work in the Virgin Islands many persons rendered valuable assistance. Outstanding among them was Dr. J. B. Thompson, Director of the Federal Experiment Station, which occupies Anna's Hope Estate in St. Croix. Dr. Thompson made me his guest during my stay in St. Croix, and furnished me with a Ford

car for use during my work on the island. He has also assisted me very materially in other ways, and I owe a very special debt of gratitude to him. Mr. M. J. Nolan, the Director of Police of St. Thomas, was of special assistance to me in that island. He greatly expedited the issuance of my collecting license, permitting me to begin collecting the minute I landed, and also supplied a Police Department car and chauffeur for use on some of my collecting trips.

So many other persons were of assistance in various ways that it is impossible to mention them all, but I must not neglect to mention my little friend Nelson Biaggi, of Mayagüez, P. R., who accompanied me on my trip to the British Islands. His cheery companionship and assistance in many ways helped very materially in making the expedition more successful than it would otherwise have been.

METHOD OF TREATMENT

In the discussion of birds which follows fifty-eight forms are mentioned, of which I actually collected or observed fifty-six.

In each of the forms covered in this paper the scientific name with the authority is given first, followed by the English name by which the bird is known in published works. In many cases that is followed by the name by which the bird is known locally. However, some birds are so rare as to have no local name, and in other cases I was unable to ascertain any local name. Then a brief general statement about the status of the birds in the Virgin Islands is given, followed by more detailed statements of my observations concerning the birds in each of the islands I visited. Following that is a list of the specimens I collected in the Virgin Islands, giving the number of each specimen in my collection, its sex, and the locality and date where each was collected. The specimens are all in my collection, which is at present deposited at the College of Agriculture and Mechanic Arts of the University of Porto Rico, at Mayagüez, P. R.

The most remarkable feature of the bird life of the Virgin Islands is the rapid dispersal of the Mockingbird through the islands which is at present taking place.

DISCUSSION OF BIRDS

PELECANUS OCCIDENTALIS OCCIDENTALIS Linné. Brown Pelican. Local Name "Pelican".

The Brown Pelican is found in suitable localities along the coasts of all the islands.

St. Croix: Noted at Frederiksted December 24, 1926 and Janu-

ary 3, 1927 (25); Krausse's Lagoon, December 27 and 31 (25); Christiansted Harbor, December 28; East End, January 1; and Buck Island, January 1.

St. Thomas: A few were noted on every visit to the Island.

St. Jan: Seen at Cruz Bay January 6–8, 1927, and off the north coast on January 3, 1929.

Tortola: Common all along the south coast in December 1928 and January 1929.

Salt Island: Fifteen were seen on December 29, 1928.

Virgin Gorda: Four were seen on January 1, 1929.

SULA LEUCOGASTRA LEUCOGASTRA (Boddaert). Common Booby.

The Booby is generally distributed, but not particularly common throughout the islands.

St. Croix: One was seen at Frederiksted on January 3, 1927.

St. Thomas: One was seen off the south coast on January 5, 1928, and on January 8 one near the east end of the island and another in St. Thomas Harbor.

St. Jan: A few were seen off the west coast on January 7 and 8, 1927, and on January 3, 1929 two in immature plumage were observed off the north coast.

Tortola: Three were seen west of Roadtown on December 25, 1928.

FREGATA MAGNIFICENS Mathews. Man-o-war Bird. Local Name "Hurricane Bird"; in St. Jan; "Weather Bird" in St. Croix.

Although I did not happen to meet this bird in St. Croix, it is well known there, and I found it on a number of the other islands. It doubtless occurs throughout them all.

St. Thomas: One was noted on December 24, 1926, and one on December 22, 1928.

St. Jan: A few were noted off the north and west coasts on January 7 and 8, 1927; and on January 3, 1929 I counted eighteen while sailing along the north coast. Fifteen of these were in one flock.

Tortola: A few were observed at Roadtown and West End on December 26, 1928 and January 3, 1929.

ARDEA HERODIAS ADOXA Oberholser. West Indian Great Blue Heron.

This bird is probably found occasionally on all the islands, although I have definite records from only three.

St. Croix: At Krausse's Lagoon one was recorded on December

27 and two on December 31, 1926. One was seen at Salt River on December 30, 1926, and one at Shoy's Lagoon on January 1, 1927.

St. Thomas: One was noted fishing in shallow water on the south coast on January 4, 1927.

Tortola: One was seen at East End on January 1, 1929.

CASMERODIUS ALBA EGRETTA (Gmelin). Egret.

The Egret is very rare in the Virgin Islands, where it has been recorded only from St. Croix.

St. Croix: Two were noted at Krause's Lagoon on December 31, 1926.

EGRETTA THULA THULA (Molina). Snowy Egret.

The Snowy Egret is rare in the Virgin Islands, where it has previously been reported only from St. Croix.

St. Thomas: One was clearly observed at Bender's Lagoon on January 4, 1927.

HYDRANASSA TRICOLOR RUFICOLLIS (Gosse). Louisiana Heron.

The Louisiana Heron has apparently not previously been recorded from the Virgin Islands, and I have only one record for it.

St. Thomas: One was seen at Bender's Lagoon on January 4, 1927.

FLORIDA CAERULEA CAERULESCENS (Latham). Southern Little Blue Heron.

The Little Blue Heron is one of the commonest and most generally distributed of the herons in the Virgin Islands. It is probably found on them all. I recorded it on all the islands visited except Virgin Gorda.

St. Croix: A few in both blue and white plumages were observed at Salt River, Cane Bay, Krausse's Lagoon and Shoy's Lagoon in December 1926 and January 1927.

St. Thomas: My only record is of three seen at Bender's Lagoon on January 4, 1927.

St. Jan: A few, in both blue and white plumages, were seen at Cruz Bay on January 6 and 8, 1927.

Tortola: Birds in both plumages were fairly common during my stay in December, 1928 and January, 1929. On December 25, 1928 I collected at one shot two birds in the white plumage. The stomach of one contained fourteen small crabs, eight of them fiddler crabs. The stomach of the other had five small *Anolis* lizards and two large red-legged grasshoppers.

Salt Island: One white plumaged bird was seen December 29, 1928 in a small fringe of mangroves.

Specimens collected:

No. 680, male, Roadtown, Tortola, Dec. 25, 1928 (white plumage).

No. 683, female, Roadtown, Tortola, Dec. 25, 1928 (white plumage).

BUTORIDES VIRESCENS MACULATUS (Boddaert). West Indian Green Heron.

The Green Heron is not as common as one would expect to find it in the Virgin Islands. St. Croix was the only island on which I found it at all common.

St. Croix: Fairly common. In December, 1926 and January, 1927 I observed it at Christiansted, Anna's Hope, Krausse's Lagoon, and Shoy's Lagoon. A stomach contained fifteen short-horned grasshoppers; a large long-horned grasshopper (*Neoconocephalus triops*); three small long-horned grasshoppers (*Conocephalus* sp.), and three medium sized spiders.

St. Thomas: Rare. I observed this species only twice, one seen in a small cattail swamp on December 31, 1927, and again on January 1, 1928.

St. Jan: One was observed at Cruz Bay on January 6, and another on January 8, 1927.

Tortola: I recorded the Green Heron three times at Roadtown, (December 25, 26, and 27, 1928).

Specimen collected:

No. 276, male, Anna's Hope, St. Croix, Jan. 1, 1927.

NYCTANASSA VIOLACEA VIOLACEA (Linné). Yellow-crowned Night Heron.

The Yellow-crowned Night Heron has been previously recorded from St. Thomas, St. Croix and Virgin Gorda.

Tortola: On December 26, 1928, I collected a juvenile female apparently scarcely out of the nest, in some mangroves near Roadtown. Its stomach was empty.

Specimen collected:

No. 686, female juv., Roadtown, Tortola, Dec. 26, 1928.

DAFILA BAHAMENSIS BAHAMENSIS (Linné). Bahama Duck.

The Bahama Duck has been previously recorded from St. Thomas. It is very rare in the Virgin Islands.

Virgin Gorda: On January 1, 1929 a pair was observed at close range on the large brackish lagoon in the southern part of Virgin Gorda.

MARILA AFFINIS (Eyton). Lesser Scaup Duck.

The Lesser Scaup Duck has been recorded previously from St. Croix and St. Thomas.

Virgin Gorda: On January 1, 1929 a flock of thirty-five was noted on the large brackish lagoon back of the beach.

BUTEO BOREALIS JAMAICENSIS (Gmelin). West Indian Red-tailed Hawk.

The Red-tailed Hawk has apparently not previously been recorded in life from the Virgin Islands, although bones are known from a kitchen midden in St. Croix.

St. Croix: One was seen at Christiansted on December 28, 1926, and one at Anna's Hope on January 1, 1927. On December 29 I was shown a specimen that had been shot by a planter while attacking his chickens a few days previously.

St. Thomas: One was observed soaring over the hills west of the town on December 30, 1927.

St. Jan: One was observed at Cruz Bay on January 6, 1927, and one in the hilly interior the following day.

Tortola: A pair was seen at Roadtown on December 25, 1928, and again on December 27, and a single bird on December 31. On January 1, 1929 a single bird was noted at East End.

PANDION HALIAËTUS CAROLINENSIS (Gmelin). Osprey. Local name, "Fish Hawk".

The Osprey is a winter visitor in small numbers to the Virgin Islands.

St. Croix: Ospreys were observed on four occasions: Krausse's Lagoon (two on December 27 and one on December 31, 1926); East End (one on January 1, 1927); Anna's Hope (one on January 1, 1927).

Tortola: One was seen at Roadtown Harbor on December 27, 1928.

Salt Island: One was collected on December 29, 1928. Its stomach contained exclusively the remains of fishes.

Specimen collected:

No. 696, male, Salt Island, Dec. 29, 1928.

FALCO PEREGRINUS ANATUM (Bonaparte). Duck Hawk.

The Duck Hawk is a rare winter visitor to the Virgin Islands, where it has previously been recorded from St. Croix and Virgin Gorda.

St. Croix: One was seen at Krausse's Lagoon on December 27, 1926.

Salt Island: One was shot but not recovered on December 29, 1928.

FALCO SPARVERIUS CARIBAEARUM (Gmelin). Antillean Sparrow Hawk. Local Name "Killi-killi Hawk".

The Killi-killi Hawk is fairly common on St. Croix, but quite rare on the other islands. Although it has been recorded from St. Thomas and St. Jan I have never observed it on those islands.

St. Croix: Fairly common at Christiansted, Anna's Hope, Southgate and Kingshill in December, 1926, and January, 1927. One stomach contained six caterpillars, a Katydid, fragments of a spider, and two *Gordia* fruits. Another had four *Anolis* lizards, and a cricket (*Gryllus* sp.).

Tortola: During my visit the only example seen was a female which I collected at Roadtown on December 28, 1928. Its stomach contained the tail, fur, and some of the bones of a young rat. The tail of the rat was three and a half inches in length. The stomach also contained two grasshoppers, (*Schistocerca colombina*).

Virgin Gorda: A pair was noted on January 1, 1929.

Specimens collected:

No. 293, female, Anna's Hope, St. Croix, Dec. 27, 1926.
No. 294, female, Anna's Hope, St. Croix, Dec. 31, 1926.
No. 692, female, Roadtown, Tortola, Dec. 28, 1928.

COLINUS VIRGINIANUS VIRGINIANUS (Linné). Quail.

Although I did not personally observe any Quail on my visit to St. Croix, I was told that a few still existed there.

RALLUS LONGIROSTRIS CARIBAEUS Ridgway. Caribbean Clapper Rail.

Clapper Rails have been recorded from St. Thomas and St. Croix, but I found none on those islands.

Tortola: Clapper Rails were common on a small mangrove Island in Roadtown harbor during the time of my visit.

GALLINULA CHLOROPUS PORTORICENSIS Danforth. Antillean Gallinule.

The only one of the Virgin Islands on which I found any Gallinules was Virgin Gorda.

Virgin Gorda: On January 1, 1929 five gallinules were observed and a female collected at the brackish lagoon back of the beach. Its stomach contained algae, small black seeds, and some

fine white sand. The specimen agrees well in coloration and measurements with examples in my collection from Porto Rico and Santo Domingo. Therefore I am considering it as belonging to the same race.

I am presenting herewith a tabulation of the measurements of the specimens of Antillean Gallinules now in my collection. The measurements are expressed in millimeters.

	Wing	Tail	Tarsus	Culmen with frontal shield	Width of frontal shield
No. 14, female, P. R, Cartagena Lagoon Apr. 4, 1924.....	174	76	53	45.5	13.5
No. 374, female, P. R., Cartagena Lagoon. Mar. 7, 1927....	168.5	80	51	48	15
No. 623, female, P. R., Aguadilla, May 7, 1928.....	163	79	55	47.5	15
No. 454 female, R. D., Laguna Salodillo, June 26, 1927....	177	80	55	50	17
No. 544, female, R. D., Laguna Salodillo, June 26, 1927....	168	75	50.5	48	14
No. 706, female, V. I., Virgin Gorda, Jan. 1, 1929.....	165	76	54	45.5	13.5

PAGOLLA WILSONIA WILSONIA (Ord). Wilson's Plover.

The Wilson's Plover has been recorded from several of the Virgin Islands, but I found it only on St. Croix.

St. Croix: Ten were observed at Krausse's Lagoon on December 31, 1926, and six at East End on January 1, 1927. The stomach of a bird collected contained fragments of a centipede.

Specimen collected:

No. 281, male, Krausse's Lagoon, St. Croix, Dec. 31, 1926.

OXYECHUS VOCIFERUS VOCIFERUS (Linné). Killdeer.

Killdeers were found by me only on St. Thomas and Salt Island.

St. Thomas: A number of Killdeers can usually be found, at least in December and January, at the edge of a small cattail swamp between the town and the docks. In my notes I find the following records: December 17, 1927 (flock of six); December 31, 1927 and January 1, 1928 (flock of nine); December 22, 1928 (several); January 4, 1929 (flock of twenty-five, out of which a male was collected.) The stomach of the bird collected contained nine large Tabanid larvae.

Salt Island: On December 29, 1928 a male was collected at a very small mudhole on the east side of the island. It was the only individual of its species seen. Its stomach contained exclusively comminuted insects, mainly Coleoptera, including a Scarabaeid beetle.

The two males from St. Thomas and Salt Island, and a male from St. Martin, are much darker and browner than three males

from Porto Rico and Santo Domingo in my collection. Their wings are also longer. Although they come within the limits given by Ridgway for *O.v. rubidus,* I am inclined to regard these birds as *O.v. vociferus,* on account of the darker coloration, and of the fact that they also come within the limits given for *vociferus.* The wing measurements of the specimens of male Killdeers from the West Indies in my collection follow: They are expressed in millimeters:

	Wings
No. 21, *O.v. rubidus,* P.R., Cartagena Lagoon, Sept. 23, 1924	140
No. 22, *O.v. rubidus,* P.R., Arecibo, Oct. 14, 1926	144.5
No. 410, *O.v. rubidus,* R.D., Haina, June 16, 1927	147
No. 557, *O.v. vociferus,* St. Martin, Great Bay, Dec. 24, 1927	161.5
No. 693, *O.v. vociferus,* Salt Island, Dec. 29, 1928	157
No. 707, *O.v. vociferus,* St. Thomas, Jan. 4, 1929	159

SQUATAROLA SQUATAROLA CYNOSURAE Thayer and Bangs. American Black-bellied Plover.

The Black-bellied Plover was observed only on St. Croix, where it was found to be common. It has not previously been recorded from the Virgin Islands.

St. Croix: Common. Fifty were observed at Krausse's Lagoon on December 27, 1926, and a hundred on December 31. On January 1, 1927 five were observed at Coakley Bay, and fifty at Southgate. The stomach of a bird collected contained 93 per cent of very small bivalve shells, and 7 per cent of very small snails.

Specimen collected:

No. 280, female, Krausse's Lagoon, St. Croix, Dec. 31, 1926.

ARENARIA INTERPRES MORINELLA (Linné). Ruddy Turnstone.

The Ruddy Turnstone almost undoubtedly occurs at times on all the islands, but I have found it only on St. Croix and Tortola.

St. Croix: Common. More than 150 were seen at Krausse's Lagoon on December 27, 1926, and about 100 on December 31. On January 1, 1927 two were noted at Southgate. The stomach of a bird collected contained fourteen small snails, four earwigs (*Anisolabia maritima*), and a little miscellaneous animal matter.

Tortola: Two were observed at Roadtown on December 25, 1928, and on December 27 one was shot but not recovered.

Specimen collected:

No. 282, male, Krausse's Lagoon, St. Croix, Dec. 31, 1926.

CAPELLA DELICATA (Ord). Wilson's Snipe.

The Wilson's Snipe has been previously recorded from St. Croix, but from none of the other Virgin Islands.

St. Croix: My only record is of one bird seen at Shoy's Lagoon on January 1, 1927.

ACTITIS MACULARIA (Linné). Spotted Sandpiper.

The Spotted Sandpiper is a fairly common and well distributed winter visitor to the Virgin Islands.

St. Croix: One was observed on the sand beach at Prosperity on December 30, 1926, one in a mangrove swamp at Shoy's Lagoon on January 1, 1927, and two on a gravel beach at East End the same day. The stomach of a bird collected was nearly filled with small Crustaceans (sand fleas). It also contained a few insects.

St. Thomas: One was seen at Bender's Lagoon on January 4, 1927, and one near the town on January 5, 1929.

St. Jan: Five were seen in mangrove swamps at Cruz Bay on January 6, 1927, and the same number the following day.

Tortola: One or two were seen at Roadtown on each of the following days: December 25, 26, 27, 28 and 30, 1928.

Virgin Gorda: One was seen at the lagoon on January 1, 1929.

Specimen collected:

No. 279, female, East End, St. Croix, Jan. 1, 1927.

TOTANUS FLAVIPES (Gmelin). Lesser Yellowlegs.

The Lesser Yellowlegs is a fairly common winter visitor to the Virgin Islands.

St. Croix: Twenty-five were observed at Krausse's Lagoon on December 27, 1926, and ten on December 31. On January 1, 1927 ten were seen at Shoy's Lagoon.

St. Thomas: Five were seen at Bender's Lagoon on January 4, 1927.

St. Jan: Five were observed near Cruz Bay on January 6, 1927, and one the following day.

Virgin Gorda: Two were noted at the brackish lagoon on January 1, 1929.

TOTANUS MELANOLEUCUS (Gmelin). Greater Yellowlegs.

Until now, the Greater Yellowlegs has not been recorded from the Virgin Islands.

St. Croix: A few were noted at Krausse's Lagoon on December

27, 1926. The stomach of a bird collected contained four fishes each about an inch in length.

Specimen collected:

No. 277, male, Krausse's Lagoon, St. Croix, Dec. 27, 1926.

PISOBIA MINUTILLA (Vieillot). Least Sandpiper.

The Least Sandpiper was found by me only on St. Croix.

St. Croix: Ten were seen at Krausse's Lagoon on December 31, 1926, and eight at Shoy's Lagoon on January 1, 1927. A stomach had two very small snails, and the wings of two termites. It also contained a large amount of sand.

Specimen collected:

No. 278, male, Krausse's Lagoon, St. Croix, Dec. 21, 1926.

THALASSEUS MAXIMUS MAXIMUS (Boddaert). Royal Tern.

The Royal Tern is fairly common in winter in the Virgin Islands. Probably it visits all the islands at times.

St. Croix: Five were seen at Frederiksted on December 24, 1926, and ten on January 3, 1927. On December 28 one was seen at Christiansted; two at Krausse's Lagoon on December 31, and one at East End on January 1.

St. Thomas: On January 3, 1929 three were seen at the entrance to the harbor.

St. Jan: Three were seen off the west coast on January 8, 1927.

Tortola: A few were observed near Roadtown on December 26, 29, and 31, 1928, and at East End on January 1, 1929.

COLUMBA LEUCOCEPHALA Linné. White-crowned Pigeon.

The White-crowned Pigeon has been recorded from St. Croix and Virgin Gorda, but I found it only on St. Croix.

St. Croix: At Anna's Hope from five to twenty-five of these large pigeons were observed feeding in the cabbage palms on December 26, 28, and 29, 1926, and on January 1 and 2, 1927. One was also observed at Krausse's Lagoon on December 31, and three at Shoy's Lagoon on January 1. The stomach of a bird collected contained five large seeded fruits.

Specimen collected:

No. 283, female, Anna's Hope, St. Croix, Dec. 28, 1926.

COLUMBA SQUAMOSA Bonnaterre. Scaled Pigeon.

The Scaled Pigeon has been previously recorded from St. Croix, St. Thomas, and St. Jan.

St. Croix: One was noted at Prosperity on December 30, 1926.

St. Jan: One was observed in the thick woods in the hilly interior on January 7, 1927.

Tortola: Two were seen in some dense rather dry woods near the summit of one of the higher hills on Tortola on December 26, 1928.

Specimen collected:

No. 685, male, Tortola, Dec. 26, 1928.

ZENAIDA ZENAIDA ZENAIDA (Bonaparte). Zenaida Dove. Local name, "Mountain Dove".

The Zenaida Dove, or Mountain Dove, as it is called locally, was found on all the islands visited.

St. Croix: The Zenaida Dove is astonishingly common and tame in St. Croix. In Porto Rico this species is so shy that on going to St. Croix it seemed hard for me to believe that I was seeing the same species. I find it recorded in my notes from Christiansted, Anna's Hope, St. John Estate, Krausse's Lagoon, Cane Bay, Prosperity, and Salt River. The contents of four stomachs were examined. They contained seeds of many kinds, among which *Cordia* sp., some Crotalaria-like seeds, and some large hooked seeds of the stick-tight type were noted. Gravel to the extent of 12 per cent of the stomach contents was also found.

St. Thomas: Rare. I have recorded the species only once (January 3, 1927).

St. Jan: Fairly common at Cruz Bay during the period of my visit.

Tortola: Observed only once (one at Roadtown on December 28, 1928).

Salt Island: Three were observed on December 29, 1928.

Virgin Gorda: About twenty-five were flushed in some brush and mangroves near the head of the brackish lagoon on January 1, 1929. The stomach of one of these contained the seeds of fruits and a little sand.

Specimens collected:

No. 284, male, St. John Estate, St. Croix, Dec. 25, 1926.
No. 285, female, Anna's Hope, St. Croix, Dec. 28, 1928.
No. 286, male, Anna's Hope, St. Croix, Dec. 29, 1926.
No. 287, male, Cane Bay, St. Croix, Dec. 30, 1926.
No. 700, female, Virgin Gorda, Jan. 1, 1929.

CHAEMEPELIA PASSERINA TROCHILA Bonaparte. Porto Rican Ground Dove. Local Name, "Ground Dove".

The Ground Dove is common in suitable localities on all the islands.

St. Croix: Common practically all over the Island. I find it recorded in my notes as common at Christiansted, Anna's Hope, Prosperity, Salt River, and East End. The stomachs of three birds shot contained exclusively small seeds. The bills of these birds were dusky brown.

St. Thomas: Common. A stomach contained small seeds, including many of the spiny, stick-tight type. It also contained a little sand, amounting to five per cent of the stomach contents. The bill of a bird collected was dusky brown, tinged with rose at the base.

St. Jan: Common. Two stomachs contained small seeds; also sand to the extent of 40 per cent of the contents. The color of the bills of the birds collected was dusky brown, with tinges of dull rose, especially at the base.

Tortola: Fairly common around Roadtown.

Salt Island: About twenty were observed on the day of my visit.

Virgin Gorda: Very common.

Specimens collected:

No. 288, male, Anna's Hope, St. Croix, Dec. 27, 1926.
No. 289, female, Anna's Hope, St. Croix, Dec. 28, 1926.
No. 290, female, Cruz Bay, St. Jan, Jan. 7, 1927.
No. 291, female, Cruz Bay, St. Jan, Jan. 7, 1927.
No. 292, male, St. Thomas, Jan. 8, 1927.
No. 676, male, Roadtown, Tortola, Dec. 25, 1928.
No. 705, female, Virgin Gorda, Jan. 1, 1929.

OREOPELEIA MYSTACEA MYSTACEA (Temminck). Bridled Quail Dove.

St. Croix: One was observed at Prosperity on December 30, 1926.

EUPSITTULA PERTINAX PERTINAX (Linné). Curacao Paroquet.

St. Thomas: On January 4, 1927, I observed a small flock in a thickly grown brushy region east of Bender's Lagoon, in the eastern part of the island. They were so wary and the brush so dense and spiny that I was unable to get within gunshot of them. However it is good to know that the paroquets still exist in St. Thomas, and as the eastern end of the island is largely wild and uncultivated they may continue to exist there for a long time. In the summer from June to August when the guinep fruits are ripe, the paroquets are

said to come to these trees in large numbers to feed, and to be much tamer and easier to shoot at that time.

COCCYZUS MINOR TERES Peters. Mangrove Cuckoo. Local Name "Mani Coco".

The Mangrove Cuckoo probably occurs at least occasionally on all the Virgin Islands, but I have recorded it from only three of them.

St. Croix: I did not find the Mangrove Cuckoo common on St. Croix. The only two examples seen were collected. The stomachs contained exclusively Orthoptera and their eggs, (*Microcentrum triangulatum*, 62.5 per cent; *Neoconocephalus triops*, 25 per cent; Locustid eggs, 12.5 per cent).

Tortola: Heard at Roadtown on December 24 and 31, 1928.

Specimens collected:

No. 297, male, Anna's Hope, St. Croix, Dec. 26, 1926.
No. 298, female, Anna's Hope, St. Croix, Dec. 28, 1926.
No. 299, female, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 300 male, Cruz Bay, St. Jan, Jan. 6, 1927.

CROTOPHAGA ANI Linné. Ani. Local Name, "Black Witch".

The Ani is a common bird throughout the Virgin Islands.

St. Croix: Common. Recorded at Christiansted, Anna's Hope, Salt River, and Shoy's Lagoon. A stomach contained a large spider carrying a very large silk case full of young spiders, and a black cricket (*Gryllus* sp).

St. Thomas: Fairly common.

Tortola: Fairly common. A stomach contained three stinkbugs (*Nezara viridula*); one grasshopper (*Plectotettrix* sp); and nine grasshoppers (*Schistocerca colombina*).

Salt Island: Three flocks, with a total of about twenty individuals were noted on the day of my visit.

Virgin Gorda: Common.

Specimens collected:

No. 296, female, Anna's Hope, St. Croix, Dec. 27, 1926.
No. 681, male, Roadtown, Tortola, Dec. 25, 1928.

ORTHORHYNCHUS EXILIS EXILIS (Gmelin). Gilt-crested Hummingbird. Local Name "Doctor Bird".

This beautiful little hummer with its brilliant metallic green crest occurs more or less commonly throughout the Virgin Islands.

St. Croix: Common. Recorded at Christiansted and Anna's

Hope. A stomach contained nothing but small insects, including a small weevil, other small beetles, and some earwigs.

St. Thomas: Fairly common.

St. Jan: Several were seen in the vicinity of Cruz Bay.

Tortola: Common around Roadtown.

Salt Island: Two were seen on December 29, 1928.

Virgin Gorda: Two were seen and one collected on January 1, 1929.

Specimens collected:

No. 301, male, Anna's Hope, St. Croix, Dec. 29, 1926.
No. 302, male, Anna's Hope, St. Croix, Dec. 29, 1926.
No. 303, male, Anna's Hope, St. Croix, Jan. 2, 1927.
No. 304, female, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 305, male, St. Thomas, Jan. 8, 1927.
No. 702, female, Virgin Gorda, Jan. 1, 1929.

SERICOTES HOLOSERICEUS HOLOSERICEUS (Linné). Blue-breasted Hummingbird. Local Name, "Doctor Bird".

This large hummer with the blue breast is common throughout the Virgin Islands.

St. Croix: Common. Recorded at Christiansted, Anna's Hope and East End. Two stomachs contained insects (mainly small beetles), and a few small spiders.

St. Thomas: Fairly common. Seen around the town and at East End.

St. Jan: Common near Cruz Bay.

Tortola: Fairly common around Roadtown.

Salt Island: Two were seen on December 29, 1928.

Virgin Gorda: Four were seen and two collected on January 1, 1929.

Specimens collected:

No. 306, female, Anna's Hope, St. Croix, Dec. 25, 1926.
No. 307, female, Anna's Hope, St. Croix, Dec. 25, 1926.
No. 308, male, Anna's Hope, St. Croix, Dec. 26, 1926.
No. 703, male, Virgin Gorda, Jan. 1, 1929.
No. 704, male, Virgin Gorda, Jan. 1, 1929.

ANTHRACOTHORAX AURULENTUS (Audebert and Vieillot). Porto Rican Mango. Local Name "Doctor Bird".

St. Thomas: Seen on four occasions in December and January.

STREPTOCERYLE ALCYON ALCYON (Linné). Belted Kingfisher.

The Kingfisher is a fairly common winter visitor to the Virgin Islands.

St. Croix: Single birds were observed on four occasions (Cane Bay, December 30, 1926; Krausse's Lagoon, December 31, 1926; East End, January 1, 1927, and Southgate, January 1, 1927).

St. Thomas: One was observed at Bender's Lagoon on January 4, 1927.

St. Jan: One was collected in some mangrove swamps near Cruz Bay on January 6, 1927. Its stomach contained a herring-like fish four and a quarter inches long, so large that it could hardly be contained in the stomach.

Tortola: From one to three individuals were seen near Road-town on each of the days from December 24 to 27, 1928, inclusive.

Specimen collected:

No. 295, male, Cruz Bay, St. Jan, Jan. 6, 1927.

TYRANNUS DOMINICENSIS DOMINICENSIS (Gmelin). Gray Kingbird. Local Names, "Chichiri" and "Chinchiri".

The Gray Kingbird is one of the most abundant resident birds in the Virgin Islands.

St. Croix: Common all over the Island. One stomach contained an assassin bug (*Zelus rubidus*), and fragments of a large Diptera. Another had a flat bug, six large winged black ants, a caterpillar, and some miscellaneous insect fragments.

St. Thomas: Abundant.

St. Jan: Very common. The stomach of a bird collected was nearly empty, and contained only a few comminuted insect fragments.

Tortola: Common. A stomach contained eight adult Lepidoptera and a few lizard bones.

Salt Island: Twelve were observed on December 29, 1928. A stomach contained a Histerid beetle (*Omalodes klugii*), 40 per cent; bones of small *Anolis* lizards, 15 per cent; fragments of Odonata, 20 per cent; Coleopterous fragments 5 per cent; and some small black seeds, 20 per cent.

Virgin Gorda: Ten were observed on January 1, 1929.

Specimens collected:

No. 309, male, Anna's Hope, St. Croix, Dec. 27, 1926.

No. 310, male, Anna's Hope, St. Croix, Jan. 1, 1927.

No. 311, female, Cruz Bay, St. Jan, Jan. 7, 1927.

No. 677, male, Roadtown, Tortola, Dec. 25, 1928.

No. 695, female, Salt Island, Dec. 29, 1928.

ELAENIA MARTINICA RIISII Sclater. Riise's Elaenia. Local Name, "John Phillip".

The Elaenia is a common bird in the Virgin Islands, but I found none on Salt Island or Virgin Gorda. It has not previously been recorded from St. Croix.

St. Croix: I found the Elaenia very common in dry brushy areas. On December 25, 1926 I counted fifteen on a dry brushy hill near Anna's Hope. In addition to this locality I found the species at Cane Bay, Coakley Bay, and Prosperity. The song is a whistled *"Cheery cheery, cheer"*. The stomachs of four birds contained 98.75 per cent of vegetable matter (berries and small drupes), and 1.25 per cent of animal matter (small spiders in one stomach).

St. Thomas: Fairly common. A stomach contained a large drupe (85 per cent), and a caterpillar (15 per cent).

St. Jan: Common. A stomach had two large green berries with flat seeds.

Tortola: Fairly common. One was collected in some dry woods on top of a high hill. Its stomach contained one small drupe.

Specimens collected:

No. 318, female, Anna's Hope, St. Croix, Dec. 25, 1926.
No. 319, female, Anna's Hope, St. Croix, Dec. 25, 1926.
No. 320, female, Anna's Hope, St. Croix, Dec. 26, 1926.
No. 321, male, Anna's Hope, St. Croix, Dec. 31, 1926.
No. 322, male, East End, St. Thomas, Jan. 4, 1927.
No. 323, male, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 685, male, Tortola, Dec. 26, 1928.

HIRUNDO ERYTHROGASTER Boddaert. Barn Swallow.

The Barn Swallow has previously been recorded from the Virgin Islands only from St. Croix.

St. Thomas: On December 17, 1927, a flock of fifteen was observed flying over a small cattail marsh between the town and the docks.

MIMUS POLYGLOTTOS ORPHEUS (Linné). Jamaican Mockingbird. Local Name, "Mockingbird".

The Mockingbird was not known from the Virgin Islands until recent years. The first record was of a series collected on St. Thomas in 1916 by R. H. Beck, recorded by Griscom and by Wetmore. Until now this remains the only published record of the species from the Virgin Islands. But more recently the Mockingbird has been spreading through the other islands, and, finding con-

ditions very favorable for its existence, it is increasing very rapidly. The type of brushy country that so abounds in the Virgin Islands is the very type of country where the Mockingbird is most abundant in Porto Rico and other islands where it has long been established.

St. Croix: I was told by residents that Mockers first appeared on the island abount ten years before my visit. During my visit I found a pair at Krausse's Lagoon on December 31, 1926, and collected the female. On January 1, 1927 I observed and collected a singing male at Southgate. One of the stomachs contained a *Cordia* fruit. The other was empty.

St. Thomas: I found the species very common on all of my visits to St. Thomas. Two stomachs contained nothing but berries and drupes.

St. Jan: About half a dozen were noted on each of the days I spent on the island in January, 1927. Two stomachs contained drupes.

Tortola: Not common, but two or three could be observed almost any day. A stomach contained three drupes.

Salt Island: One was observed singing on December 29, 1928.

Virgin Gorda: A singing bird was seen on January 1, 1929.

Specimens collected:

No. 312, female, Krausse's Lagoon, St. Croix, Dec. 31, 1926.
No. 313, male, Southgate, St. Croix, Jan. 1, 1927.
No. 314, male, East End, St. Thomas, Jan. 4, 1927.
No. 315, male, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 316, female, Cruz Bay, St. Jan, Jan. 7, 1927.
No. 684, male, Roadtown, Tortola, Dec. 26, 1928.
No. 688, male, Roadtown, Tortola, Dec. 27, 1928.

MARGAROPS FUSCATUS FUSCATUS (Vieillot). Pearly Eyed Thrasher. Local Name, "Thrush".

The Pearly Eyed Thrasher is a common resident in the Virgin Islands. It is found most abundantly on brushy hillsides.

St. Croix: A few were observed at Anna's Hope, and the species was found to be common at Prosperity.

St. Thomas: Fairly common.

St. Jan: Very common in the hilly interior, less so near the coast. They were in song at the time of my visit. A stomach was nearly filled with fleshy fruits, but also contained one small beetle.

Tortola: Very common on the wooded brushy hills. A stomach contained eleven red solanaceous berries and two hard black seeds.

Specimens collected:

No. 324, female, Cruz Bay, St. Jan, Jan. 6. 1927.
No. 674, male, Tortola, Dec. 24, 1928.

COEREBA PORTORICENSIS SANCTI-THOMAE (Sundevall). Virgin Island Honey Creeper. Local Name, "Yellow Breast".

In my series of Honey Creepers from the Virgin Islands, except St. Croix, I find that the characteristics given by Wetmore for this subspecies hold true. These characteristics are that the yellow of the underparts is brighter and clearer than that of the Porto Rican birds, and that the flanks are paler.

St. Thomas: Fairly common and generally distributed. On January 1, 1928 one was observed building a nest of wild cotton and fine twigs and roots in the lower branches of a tree about six feet above the ground. At that time the nest was about one quarter completed. The stomach of a bird collected on St. Thomas contained ten small black seeds and some insect fragments.

St. Jan: Common. Three stomachs were examined. One was empty, the second contained a few insect fragments, and the third contained thousands of pollen grains amounting to 40 per cent of contents, and insect fragments amounting to 60 per cent.

Tortola: Common and breeding in December, 1928.

Virgin Gorda: Common in the brushy region around the edges of the large brackish lagoon. Two stomachs had nothing but comminuted insects. A Thrips was recognized in one, and two small Lepidopterous larvae in the other.

Specimens collected:

No. 334, female, East End St. Thomas, Jan. 4, 1927.
No. 335, male, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 336, female, Cruz Bay, St. Jan, Jan. 7, 1927.
No. 337, female, Cruz Bay, St. Jan, Jan. 7, 1927.
No. 672, male, Roadtown, Tortola, Dec. 24, 1928.
No. 679, male imm., Roadtown, Tortola, Dec. 25, 1928.
No. 698, male imm., Virgin Gorda, Jan. 1, 1929.
No. 699, female, Virgin Gorda, Jan. 1, 1929.

COEREBA NEWTONI (Baird). St. Croix Honey Creeper. Local Name, "Yellow Breast".

St. Croix: This Honey Creeper, which is confined to the Island of St. Croix, is very common and generally distributed on that island. During my visit in December, 1926 and January 1927 I observed many nests similar to those of *C. portoricensis* placed at

heights of from ten to twenty feet in tamarind and other trees. The iris of the specimens collected was hazel brown. The bill was black, while the fleshy rictus was light pink in color. The legs and feet were mouse gray, the soles of the feet being tinged with yellow. The general appearance, notes and habits of this bird are indistinguishable from those of the Porto Rican species. The contents of five stomachs were examined. Insects formed 90 per cent of the contents, while fine bits of white eggshell in one stomach formed ten per cent of the total contents. Small Lepidopterous larvæ formed 31 per cent; Coleoptera 22, per cent; small Dipteria, 4 per cent; Thysanoptera, 2 per cent; and miscellaneous comminuted insects, 31 per cent.

Specimens collected:

No. 329, male, Anna's Hope, St. Croix, Dec. 26, 1926.
No. 330, male, Anna's Hope, St. Croix, Dec. 29, 1926.
No. 331, male, Anna's Hope, St. Croix, Dec. 30, 1926.
No. 332, male, Anna's Hope, St. Croix, Dec. 31, 1926.
No. 333, female, Anna's Hope, St. Croix, Jan. 2, 1927.

MNIOTILTA VARIA (Linné). Black and White Warbler.

In the Virgin Islands I have found the Black and white Warbler only on St. Croix. However, it has been recorded from St. Thomas, and doubtless occurs on other of the islands as a winter visitor.

St. Croix: Two were seen at Anna's Hope on December 26, two on December 29, 1926, and one on January 2, 1927. One was also noted at Prosperity on December 30, 1926.

Specimen collected:

No. 338, female, Anna's Hope, St. Croix, Dec. 26, 1926.

COMPSOTLHYPIS AMERICANA PUSILLA (Wilson).
Northern Parula Warbler.

The Parula Warbler is probably the most common of the migrant warblers in the Virgin Islands.

St. Croix: One or two individuals were noted at Anna's Hope on December 25, 26, 28 and 29, 1926, and on January 1 and 2, 1927. At Cane Bay one was seen on December 30, 1926. On January 1, 1927 one was observed at Shoy's Lagoon and one at East End. A stomach contained exclusively comminuted insects and their eggs.

St. Thomas: One was noted on each of the following dates: December 24, 1926; December 30 and 31, 1927; January 1 and December 23, 1928.

Tortola: Common near Roadtown from December 24, 1928 to

January 2, 1929. A male and a female were collected, but both were too much damaged to save as specimens.

Specimen collected:

No. 340, sex? Anna's Hope, St. Croix, Dec. 25, 1926.

DENDROICA PETECHIA CRUCIANA Sundevall. Porto Rican Golden Warbler. Local Name, "Canary".

The Golden Warbler is a common resident in the Virgin Islands, frequenting mainly the mangroves, but also occurring in other habitats.

St. Croix: Common. Found most abundantly in the mangroves, but frequently observed in the larger shade trees at some distance from the sea. I find the species recorded in my notes from Anna's Hope, Cane Bay, Salt River, Krausse's Lagoon, and Shoy's Lagoon. Three stomachs contained nothing but comminuted insects, mainly Coleoptera.

St. Thomas: Fairly common. Found in the mangroves, dry brushy regions, and shade trees. A stomach contained 95 per cent of insects (beetles and other); also two spiders amounting to 5 per cent of the contents.

St. Jan: Fairly common in dry brushy places as well as in the mangroves. A stomach contained a spider (50 per cent); insect eggs (15 per cent), and some unidentifiable insect fragments (35 per cent).

Tortola: Common in the mangroves and in the brush growing immediately back of the beaches, but not observed elsewhere. A stomach contained a large Lepidopterous larva *Oxydia* sp. (92 per cent); a very small brown cockroach (4 per cent); an aphid (1 per cent); and some miscellaneous insect fragments (3 per cent).

Specimens collected:

No. 346, female, Anna's Hope, St. Croix, Dec. 27, 1926.
No. 347, male, Krausse's Lagoon, St. Croix, Dec. 27, 1926.
No. 348, male, Shoy's Lagoon, St. Croix, Jan. 1, 1927.
No. 349, male, East End, St. Thomas, Jan. 4, 1927.
No. 350, male, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 678, female, Roadtown, Tortola, Dec. 25, 1928.
No. 687, female, Roadtown, Tortola, Dec. 27, 1928.

DENDROICA DISCOLOR (Vieillot). Prairie Warbler.

The Prairie Warbler is one of the common warblers that visit the Virgin Islands in winter. It occurs mostly in dry brushy regions

while in these islands, although a few are occasionally seen in the mangroves.

St. Croix: At Anna's Hope two were observed on December 25, one on December 26, one on December 28, three on December 29, and six on December 31, 1926; and one on January 1 and two on January 2, 1927. Two were also seen at Shoy's Lagoon on January 1, 1927. A stomach contained nothing but insects, mostly beetles, including a small Cocinellid.

St. Thomas: One was seen on December 24, 1926, two on January 3, 1927, one on January 8, 1927, and three on January 1, 1928. A stomach contained only comminuted insects, largely Coleoptera.

St. Jan: Three were observed near Cruz Bay on January 6, and one on January 7, 1927. A stomach had comminuted insects, (beetles and others); also six large insect eggs.

Tortola: One was seen on a high hill on December 24, two in some mangroves on December 25, and two in a dry brushy region on December 26, 1928.

Virgin Gorda: Two were seen on January 1, 1929.

Specimens collected:

No. 351, male, Anna's Hope, St. Croix, Dec. 26, 1926.
No. 352, female, St. Thomas, Jan. 3, 1927.
No. 353, female, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 675, female, Tortola, Dec. 24, 1928.

SEIURUS NOVEBORACENSIS NOVEBORACENSIS (Gmelin). Water-thrush.

The Water-thrush is a very common winter visitor to the Virgin Islands, where it is mostly confined to the coastal mangroves and the vicinity of small streams.

St. Croix: Common. Recorded at Anna's Hope, Krausse's Lagoon, Salt River, and Shoy's Lagoon, from December 25, 1926 to January 2, 1927. Two stomachs contained mostly insects, among which Coleoptera figured prominently. A Carabid beetle was recognized in one stomach. Two seeds were found in one stomach, also a small snail.

St. Thomas: One was noted at Benner's Lagoon on January 4, 1927.

St. Jan: Eight were counted in mangrove swamps near Cruz Bay on January 6. 1927. A stomach contained only comminuted insects, among which a small Lygaeid bug and a *Notonecta* sp. were recognized.

Tortola: Common from December 25, 1928 to January 2, 1929. Two stomachs contained nothing but insects, mainly Coleoptera.

Virgin Gorda: Two were observed in the mangroves bordering the brackish lagoon on January 1, 1929.

Specimens collected:

No. 342, female, Salt River, St. Croix, Dec. 25, 1926.
No. 343, female, Anna's Hope, St. Croix, Jan. 2, 1927.
No. 344, male, Cruz Bay, St. Jan, Jan. 6, 1927.
No. 689, male?, Roadtown, Tortola, Dec. 27, 1928.
No. 690, female, Roadtown, Tortola, Dec. 27, 1928.
No. 691, female, Roadtown, Tortola, Dec. 28, 1928.

SEIURUS NOVEBORACENSIS NOTABILIS Ridgway. Grinnell's Water-thrush.

St. Croix: An example was collected at Anna's Hope on December 28, 1926, and is the first record for the island. Its stomach contained five small snails (45 per cent); and insect fragments, mainly Coleoptera, (55 per cent).

Specimen collected:

No. 345, male, Anna's Hope, St. Croix, Dec. 28, 1926.

SEIURUS AUROCAPILLUS AUROCAPILLUS (Linné). Ovenbird.

The Ovenbird doubtless occurs as a winter visitor on most of the Virgin Islands, but I have found it only on St. Croix and Tortola.

St. Croix: One was observed at Anna's Hope on December 28, two on December 29, 1926, and three on January 2, 1927. A stomach contained gravel, 12 per cent; a small snail, 2 per cent; the silky eggcase of a spider, 40 per cent; fragments of insects, 36 per cent, and seeds, 10 per cent.

Tortola: One was observed on a brushy hill above Roadtown on December 24, 1928.

Specimen collected:

No. 341, female, Anna's Hope, St. Croix, Dec. 29, 1926.

SETOPHAGA RUTICILLA (Linné). Redstart.

The Redstart is a fairly common winter visitor to the Virgin Islands.

St. Croix: From one to four individuals were observed at Anna's Hope on December 26, 27, 28, 29 and 31, 1926, and on January 2, 1927. One was seen at Cane Bay on December 30, 1926, and another at Prosperity the same day. A male was shot at Anna's

Hope on January 2, but it was too hopelessly damaged to save as a specimen. The majority of the birds seen were in the female plumage, but a few high-plumaged males were noted.

St. Thomas: A bright plumaged male was collected on January 3, 1927. 95 per cent of its stomach contents consisted of comminuted insects, among which some weevils were noted. Spiders constituted 5 per cent of the stomach contents.

St. Jan: A bird in female plumage was seen in a mangrove swamp near Cruz Bay on January 6, 1927.

Tortola: Two were observed near Roadtown on December 26, and one on December 31, 1928, none of them bright plumaged males. A stomach contained exclusively insects and their eggs, (a fleabeetle, *Cryptocephalus* sp., 10 per cent; two small weevils, 10 per cent; a Lantern Fly, 30 per cent; fifteen insect eggs, 10 per cent; miscellaneous insect fragments, 40 per cent).

Specimens collected:

No. 339, male, St. Thomas, Jan. 3, 1927.

No. 697, male, Tortola, Dec. 31, 1928.

ICTERUS ICTERUS RIDGWAYI (Hartert). Troupial.

St. Thomas: Although I did not succeed in finding the Troupial in St. Thomas, I was universally assured by residents of the island that it is still found commonly there, but that in the winter they are difficult to see, while in the summer they become tamer and come around the houses more freely.

TIARIS BICOLOR OMISSA Jardine. Carib Grassquit. Local Name "Sinbird" in St. Croix; "Sparrow" in St. Thomas and the British Islands.

The Carib Grassquit is a very common resident in the Virgin Islands.

St. Croix: Common resident; recorded at practically every locality visited. Two stomachs were filled with very small seeds.

St. Thomas: Common. On December 31, 1927 an albinistic individual was noted among a flock of eight grassquits. It was of a very light yellowish brown color, nearly white in spots. A stomach contained small seeds, also sand to the extent of 30 per cent of the stomach contents.

St. Jan: Abundant. A stomach contained seeds, also sand (40 per cent).

Tortola: Common. Breeding in December, 1928.

Salt Island: The commonest land bird on the Island.
Virgin Gorda: Common.
Specimens collected:
No. 325, female, Anna's Hope, St. Croix, Dec. 25, 1926.
No. 326, male, Anna's Hope, St. Croix, Dec. 28, 1926.
No. 327, female, Interior of St. Jan, Jan. 7, 1927.
No. 328, male, St. Thomas, Jan. 8, 1927.
No. 673, male, Roadtown, Tortola, Dec. 24, 1928.
No. 694, female, Salt Island, Dec. 29, 1928.
No. 701, male, Virgin Gorda, Jan. 1, 1929.

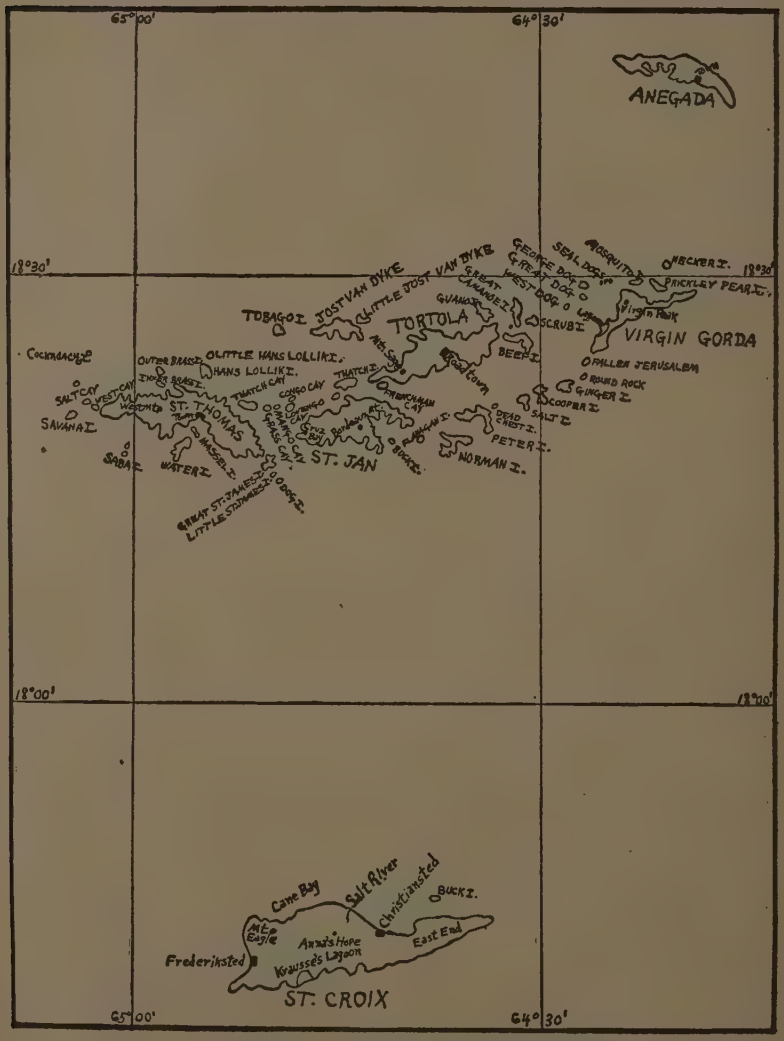

FIG. I.—MAP OF THE VIRGIN ISLANDS
(Adapted from map in Wetmore's "Birds of Porto Rico and the Virgin Islands".)

BIRDS OF ST. CROIX

By Harry A. Beatty,

Estate Constitution Hill, St. Croix, V. I., U. S. A.

[Note: In response to an urgent request, Mr. Beatty has prepared this valuable paper giving the result of his years of study of the birds of St. Croix. Many species are here recorded for the first time from that island, and one (the Canadian Warbler) is new to the known avifauna of the West Indies. While I was in St. Croix I examined the greater part of Mr. Beatty's collections of birds and eggs. I have somewhat revised the original manuscript as given to me by Mr. Beatty by changing the order in which the birds are listed, inserting the scientific names, and making other slight changes of an editorial nature. S. T. Danforth.]

St. Croix, the largest of the American Virgin Islands, is twenty-one miles long, varying in width from one to four and a half miles, and is traversed by a broken range of hills from east to west, attaining its greates height in Mount Eagle, with an altitude of 1,165 feet.

The eastern end of the range is overgrown with brush and cacti, and many of the valleys are now dense jungles. The western portion of the range rises abruptly from the coast line on the north, hence there are many deep valleys clothed in verdant jungles, with an abundance of fruit trees. The south side of the island is mostly flat land, devoted principally to the cultivation of sugar cane.

The ponds include: Kager's, Coakley Bay, South Gate, Rust-op-twist, and Two Williams; the amount of water in them depends on the rainfall and the accumulation off of the hills, and as there are no running streams to offset the tremendous loss by evaporation they are often dry for many months in the year, which affects the water fowl population. Narrow strips of land, from 100 to 200 feet in width, overgrown with manchineel, sea grape, acacia and nichol vines, separate the ponds, with their fringe of mangroves and brackish water, from the sea.

The mangrove-fringed lagoons, including Krause, the Salt Pond, Billy French, and Hammer Pond, are all separated by narrow strips of land from the sea, with which they are directly connected by two or three small channels.

In conclusion I wish to commend my pal George Seaman, who is now residing on the island, for his friendship and the interest he manifested in the accumulation of data on the birds of St. Croix.

1. *PODILYMBUS PODICEPS ANTILLARUM* (Bangs). Antillean Grebe.

I observed four on October 25, 1922 at Krause Lagoon. George Seaman saw four on December 10, 1923 on Krause Lagoon, and collected one specimen; saw two Jan. 20, 1924, on Two Williams Pond, and collected one.

2. *PELECANUS OCCIDENTALIS OCCIDENTALIS* (Linné). Brown Pelican. Local Name, "Pelican".

Resident. Common. Breeds in February and March on the mainland and Buck Island. March 10. 1924, I collected a set of two eggs, $3.08 \times 1.94''$; and $3.12 \times 1.88''$ white chalky shells, nest stained.

3. *FREGATA MAGNIFICENS* (Mathews). Man-o-War Bird. Local Names "Weather Bird" and Hurricane Bird.

Arrives early in February, and remains until July. I have never found them nesting, although they are found in large numbers on Buck Island.

4. *ARDEA HERODIAS ADOXA* (Oberholser). West Indian Great Blue Heron. Local Name, "Blue Gaulin".

Uncommon. Usually seen on the open pastures around Krause Lagoon and on the sea coast, in the shallows. Although I am certain that they nest on the island I have been unable to locate nests or young birds.

5. *CASMERODIUS ALBUS EGRETTA* (Gmelin). Egret. Local Name, "White Gaulin".

Uncommon. After many years of persistent searching my efforts were finally rewarded on March 30, 1924, when I found the nesting site of the colony. Along with other species, there were two nests of this species situated near the top of a large clump of mangroves which grew far out in the least inviting part of Krause Lagoon. One nest was empty, and the other contained two downy white chicks and one addled egg, which I handled very carefully, and is now in my collection. It measures $2.22 \times 1.63''$, and is pale greenish blue in color.

6. *EGRETTA THULA THULA* (Molina). Snowy Egret. Local Name, "White Gaulin".

Resident, and increasing in numbers; at present not uncommon. I collected two sets of eggs on March 30, 1924; one set of three,

1.75 × 1.28″, 1.75 × 1.28″, 1.72 × 1.31″; one set of two eggs. 1.59 × 1.25″ and 1.69 × 1.25″. Nests in colony at Krause Lagoon, of coarse sticks loosely put together to form a platform. Eggs pale greenish blue.

7. *FLORIDA CAERULEA CAERULESCENS* (Latham). Southern Little Blue Heron. Local Name "Blue Gaulin".

Resident, and increasing in numbers; at present not uncommon. Found them breeding in colony at Krause Lagoon with other species. A set of three eggs collected March 30, 1924, were greenish blue, 1.75 × 1.31″, 1.75 × 1.31″, and 1.78 × 1.38″. Nest a frail platform of coarse sticks.

8. *BUTORIDES VIRESCENS MACULATUS* (Boddaert). West Indian Little Green Heron. Local Name, "Least Pond Gaulin".

Resident. Very common. I have found nests in almost every month of the year. I collected a set of three eggs August 4, 1919, 1.50 × 1.13″, 1.50 × 1.13″, and 1.59 × 1.13″, pale greenish in color; nest a frail platform of coarse sticks placed twenty-five feet up on the horizontal branch of a mahogany tree on Constitution Hill, far from water.

9. *NYCTICORAX NYCTICORAX NAEVIUS* (Boddaert). Black Crowned Night Heron.

March 20, 1922, I shot a male on South Gate Pond.

10. *NYCTANASSA VIOLACEA VIOLACEA* (Linné). Yellow Crowned Night Heron. Local "Night Gaulin".

Resident; a very common species. A set of three eggs taken May 4, 1922, was greenish blue in color, and measured 2.16 × 1.50″, 2.16 × 1.50″, and 2.03 × 1.47″; nest a bulky platform of coarse sticks stituated in a mahogany sapling, seven feet above the ground.

11. *DENDROCYGNA ARBOREA* (Linné). West Indian Tree Duck.

Resident. Now very rare on the island, where fifteen years ago it was very common, and used to breed.

12. *DENDROCYGNA AUTUMNALIS* (Linné). Black-bellied Tree Duck.

I collected a male May 18, 1919, on South Gate Pond.

13. *MARECA AMERICANA* (Gmelin). Baldpate.

George Seaman shot a male Nov. 11, 1921, on Krause Lagoon.

14. *ANAS BOSCHAS BOSCHAS* (Linné). Mallard.

Shot a male in perfect plumage March 14, 1919, on Southgate Pond.

15. *DAFILA ACUTA TZITZIHOA* (Vieillot). Pintail.

Collected a male and female Nov. 5, 1921, on Krause Lagoon.

16. *DAFILA BAHAMENSIS BAHAMENSIS* (Linné). Bahama Duck. Local Name, "Brass Wing Teal".

Resident, not common. In March and April I have seen ducklings of this species on South Gate Pond. No nests or eggs were found by me.

17. *QUEREQUEDULA DISCORS* (Linné). Blue Winged Teal.

Observed ten on Oct. 5, 1921, and eight on Nov. 24, 1922, on South Gate Pond, and collected four specimens; also ten on January 5, 1923, and thirty on Feb. 10, 1924, on Krause Lagoon, and collected three specimens.

18. *ERISMATURA JAMAICENSIS JAMAICENSIS* (Gmelin). West Indian Ruddy Duck.

Collected four specimens from a flock of ten Oct. 5, 1922, on South Gate Pond.

19. *BUTEO BOREALIS JAMAICENSES* (Gmelin). West Indian Red-tailed. Local Name, "Chicken Hawk".

Resident. A few found in isolated pairs over the island, and they seem to maintain their numbers well from year to year considering that many of them are shot. I located a nest on March 3, 1922, constructed of coarse sticks, bulky, with a depression in the center. The two dull white eggs measured $2.22 \times 1.38''$, and were nest stained brownish. The nest was situated about seventy-five feet up at the top of a "water wood" tree that grew in a heavily wooded locality bear Constitution Hill. February 17, 1924, I examined another nest which was composed of coarse sticks and placed fifty feet up in the crotch of a limb on a mahogany tree near estate La Grange; the two fresh dull white eggs, slightly nest-stained each measured $2.28 \times 1.38''$. Both sets are in my collection.

20. *PANDION HALIAËTUS CAROLINENSIS* (Gmelin). Osprey.

Regular winter visitant, not uncommon. May 6 (2); August 13 (2); November 27 (2); March 23 (2); April 9 (2); September 24 (2). Specimens collected.

21. *FALCO COLUMBARIUS COLUMBARIUS* (Linné). Pigeon Hawk.

Regular winter visitant. Nov. 5 (4); Nov. 26 (1), near Krause Lagoon. Feb. 23 (1); Jan. 1 (1), at Estate La Grange. Two specimens collected.

22. *FALCO SPARVERIUS CARIBAEARUM* (Gmelin). Antillean Sparrow Hawk. Local Name "Killy-killy".

Resident. Very common, and found on all parts of the island. Nest in holes in trees; breed from February to May. Collected a set of three fresh eggs May 28, 1919 that were resting on the bare wood at the bottom of a hole two feet deep, in a "Thibet" tree on Estate Constitution Hill. The eggs measured 1.44 × 1.16″; 1.44 × 1.16″; 1.41 × 1.16″; they were straw brown in color very evenly peppered with chocolate and brown specks.

23. *COLINUS VIRGINIANUS VIRGINIANUS* (Linné). Quail. Local Names "Quail" and "Quail-dle".

Resident. Rapidly decreasing in numbers, and now their range is restricted to the cattle pastures of the south side of the island. I collected a set of ten eggs May 11, 1924, on Estate "Envy".

24. *RALLUS LONGIROSTRIS CARIBAEUS* (Ridgway). Caribbean Clapper Rail.

Resident. Common in the mangroves bordering Krause Lagoon, the only place on the island where they are found. Aug. 27, 1919, I flushed a bird from her nest, hidden in a bed of tall "pond weeds" that grow on the elevations above the water's level. The nest was composed of "pond weeds" placed six inches above the ground. The set of seven eggs, which I collected, measured as follows: 1.75 × 1.19″; 1.75 × 1.19″; 1.72 × 1.19″; 1.72 × 1.19″; 1.69 × 1.19″; 1.75 × 1.19″ 1.72 × 1.16″; glossy cream white color with large blackish and dark spots.

25. *PORZANA CAROLINA* (Linné). Sora.

A regular winter visitant; common on all the ponds, and Krause Lagoon. Jan. 5, 1922, I saw 20 on South Gate Pond; Oct. 22, 1922, 30 on Two Williams Pond; Dec. 10, 1922, 25 on South Gate Pond; Feb. 5, 1923, 25 on Krause Lagoon; Mar. 20, 1923, 25 on Krause Lagoon. Many specimens were collected.

26. *GALLINULA CHLOROPUS PORTORICENSIS* (Danforth). Antillean Gallinule. Local Name "Waterfowl".

Not an abundant species, but found on all the ponds and lagoons.

Breeds from March to July. A set of six eggs taken July 22, 1919, measured as follows: Four eggs, 1.81 × 1.31″; two eggs, 1.79 × 1.31″. A single rotten egg taken from another nest measured 1.75 × 1.28″. Nest made of "rushes", shaped into a platform, deeply cupped, and placed two feet above the water among the growing "rushes". Eggs glossed creamy white with large and small brown and light brown spots.

27. *FULICA AMERICANA GRENADENSIS* (Riley). West Indian Coot.

Common on all the ponds and lagoons, where they breed from July to October. Aug. 10, 1919, I took seven eggs from a nest which was composed of coarse sticks forming a platform on a mangrove branch extended on the surface of the water on South Gate Pond. Eggs measured as follows: 4 eggs, 1.94 ×1.31″; 3 eggs 1.97 ×1.31″; dull white with a dusky tint and sprinkled with blackish. (Note: In a letter Mr. Beatty especially calls my attention to the fact that he has never found *F. caribaea* on St. Croix, S. T. D.)

28. *CHARADRIUS NIVOSUS TENUIROSTRIS* (Lawrence). Cuban Snowy Plover.

Migrant. Arrives in April and leaves in September. Occurs in lesser numbers than the Wilson's Plover. I collected three eggs May 25, 1921, 1.50 × 1.00″; 1.48 × 1.00″; 1.48 ×1. 00″, creamy white ground color spotted and scrawled with brown and light brown. Nest a depression in the sand, unlined, among weeds.

29. *CHARADRIUS SEMIPALMATUS* (Bonaparte). Semipalmated Plover.

Irregular transient visitor. Krause Lagoon, Nov. 11 (6); Sept. 1 (6). Specimens collected.

30. *OCTHODROMUS WILSONIUS WILSONIUS* (Ord). Wilson's Plover.

Summer resident. Occurs in small numbers on Krause Lagoon, Hammer Pond, and Salt Pond, where they nest on the sandy stretches, depositing their eggs, usually three, in a depression in the sand, sometimes lined with bits of broken shells. Arrive in January, and leave in October. Three eggs taken May 15, 1922, measure 1.50 × 1.08″; 1.50 × 1.08″; and 1.44 × 1.08″, buffy white, spotted and scrawled with brown, light brown, and dusky.

31. *OXYECHUS VOCIFERUS VOCIFERUS* (Linné). Killdeer.

Jan. 7, 1922 (12); Feb. 15, 1922 (10); in ploughed field on La Grange Estate on both occasions. Three collected.

32. *PLUVIALIS DOMINICUS DOMINICUS* (Muller). Golden Plover.

Shot a male out of three observed at Krause Lagoon, Dec. 29, 1921.

33. *SQUATAROLA SQUATAROLA CYNOSURAE* (Thayer & Bangs). Black-bellied Plover.

Shot a male out of three seen May 6, 1922. A specimen was collected by George Seaman.

34. *ARENARIA INTERPRES MORINELLA* (Linné). Ruddy Turnstone.

Regular transient visitor. Observations, Aug. 15 (12); Aug. 13 (20); Nov. 11 (6); Nov. 26 (12); Nov. 29 (50); Jan. 8 (6); Mar. 23 (6); April 14 (12); May 6 (6); May 31 (10). Frequent the seacoast, Krause Lagoon, and Saltpond. Several specimens collected.

35. *GALLINAGO DELICATA* (Ord). Wilson's Snipe.

Regular transient visitor. Sept. 2 (3); Nov. 26 (40); Mar. 10 (30); Oct. 22 (1); Jan. 1 (25), all at Krause Lagoon. Several specimens collected.

36. *PHAEOPUS HUDSONICUS* (Latham). Hudsonian Curlew.

Shot a female out of a pair Aug. 13, 1922, at Krause Lagoon.

37. *ACTITIS MACULARIA* (Linné). Spotted Sandpiper.

Regular transient visitor. Krause Lagoon, Aug. 13 (1); Jan. 8 (4); Sept. 1 (5); Jan. 1 (8). Specimens collected.

38. *TRINGA SOLITARIA SOLITARIA* (Wilson). Solitary Sandpiper.

Shot a pair on Coakley Bay Pond, Sept. 20, 1919.

39. *CATOPTROPHORUS SEMIPALMATUS SEMIPALMATUS* (Gmelin). Willet.

Regular transient visitant. Observations, Sept. 1 (12); Nov. 26 (20); Nov. 29 (about 100); Dec. 29 (24); Feb. 10 (10); Apr. 6 (4); May 6 (4); May 22 (6); May 31 (1), Krause Lagoon. Specimens collected.

40. *TOTANUS FLAVIPES* (Gmelin). Lesser Yellowlegs.

Regular transient visitant. Observations, Krause Lagoon, Aug. 13 (4); Sept. 5 (24); Oct. 1 (20); Nov. 24 (20); Nov. 29 (60); Dec. 29 (15); Mar. 20 (5); May 1 (3); June 1 (50); June 12 (6). Specimens collected.

41. *TOTANUS MELANOLEUCUS* (Gmelin). Greater Yellowlegs.

Uncommon transient visitant. Observations, Krause Lagoon, Sept. 4 (25); Oct. 22 (4); Nov. 26 (2). Specimens collected.

42. *PISOBIA MINUTILLA* (Vieillot). Least Sandpiper.

Regular transient visitor. Observations. July 25 (2); Aug. 13 (50); Sept. 5 (24); Sept. 10 (about 100); Nov. 29 (about 100); Dec. 29 (30); Mar. 23 (15); May 6 (about 100). Many specimens collected.

43. *PISOBIA MELANOTOS* (Vieillot). Pectoral Sandpiper.

Oct. 1 (12); Nov. 2 on pasture land after heavy rains, near Two Williams Pond. Four specimens collected.

44. *LIMNODROMUS GRISEUS GRISEUS* (Gmelin). Dowitcher.

Collected two specimens from a flock of ten, Dec. 11, 1921, Krause Lagoon.

45. *EREUNETES PUSILLUS* (Linné). Semipalmated Sandpiper.

Regular transient visitor. Observations, Sept. 1 (25); Sept. 10 (50); Nov. 24 (10); Nov. 29 (about 100); Dec. 29 (30); Jan. 8 (2); Mar. 23 (10). Frequents the same places as the Least Sandpipers, and often found in the same flocks.

46. *LIMOSA FEDOA* (Linné). Marbled Godwit.

Shot a female out of a pair, Nov. 11, 1921, at Krause Lagoon.

47. *TRINGA CANUTUS* (Linné). Knot.

Shot a male on Krause Lagoon, Dec. 11, 1921.

48. *HIMANTOPUS MEXICANUS* (Müller). Black Necked Stilt. Local Name, "Red-Shank".

Small numbers were found nesting in May and June on Krause Lagoon and Rust-op-twist Pond. Arriving in March they raise their brood, and depart in September. I collected three eggs June 14, 1921. Nest a hollow in the sand, four feet from the water's edge scantily lined with broken pieces of sticks. Eggs measured 1.72 × 1.16"; 1.72 × 1.16"; and 1.74 × 1.16"; buffy clay color heavily spotted with dusky and blackish brown.

49. *LARUS ATRICILLA ATRICILLA* (Linné). Laughing Gull. Local Names, "Sea-gull", and "Booby".

Arrive about April in small numbers, and stay until the early part of September. A few birds apparently breed on Krause La-

goon. I observed immature birds in August, but found no nests with eggs.

50. *STERNA DOUGALLII DOUGALLII* (Montagu). Roseate Tern. Local Name, "Sea-gull".

Occurs in small numbers, rarely in cocks of from six to ten birds, from March to October. I observed immature birds in August on Krause Lagoon. They also breed on Bank Island. No eggs collected.

51. *STERNA FUSCATA FUSCATA* (Linné). Sooty Tern.

I shot a male on the rocks at Hams Bluff, March 20, 1924.

52. *STERNA ALBIFRONS ANTILLARUM* (Lesson). Least Tern. Local Name "Sea-swallow".

Arrive in April and depart in September. A colony of about 150 birds breeds on the sandy flats of Krause Lagoon and another of about the same size at the Salt Pond. I collected a set of two eggs June 20, 1919, both the same size $1.28 \times .94''$; grayish white with large blackish spots. Nest a depression in the sand, unlined.

53. *THALASSEUS MAXIMUS MAXIMUS* (Boddaert). Royal Tern.

Regular visitant. March 5 (3); May 22 (3); Sept. 1 (2); Sept. 20 (8); Sept. 24 (4); Oct. 1 (50); Oct. 6 (6); Nov. 22 (10); Nov. 27 (3); Feb. 10 (2). No nesting records. Specimens collected.

54. *COLUMBA LEUCOCEPHALA* (Linné). White Crowned Pigeon. Local Names, "Blue Pigeon", and "White-head".

Arriving in March they scatter over the island to feed until May and June, when they gather in countless numbers on Green Quay islet to breed. They build their frail nests of sticks so close together that it is impossible to take a step for fear of destroying eggs and young. A set of two glossy white eggs measured $1.44 \times 1.09''$; $1.50 \times 1.09''$; taken June 21, 1921. A few birds always stay on the island, keeping to the heavy woods of the North Side.

55. *COLUMBA SQUAMOSA* (Bonnaterre). Scaled Pigeon. Local Names, "Blue Pigeon", and "Red-head".

Resident. Occurs in small numbers. Confined chiefly to the North Side woods. Breeds in July and August. A nest found July 25, 1921, was a very frail platform of coarse sticks, situated twenty-five feet up on the forked branch of a mahogany tree. I could see plainly the two glossy white eggs through the nest from below. Eggs

measured 1.50 × 1.03″; 1.47 × 1.03″. It is not unusual to find nests with only one egg or chick.

56. *ZENAIDA ZENAIDA ZENAIDA* (Bonaparte). Zenaida Dove. Local Name, "Mountain Dove".

Resident in large numbers, but during May and June greater numbers of birds come to Green Quay islet to breed, nesting in company with the White-crowned Pigeons, and leave in July. Resident birds breed on the mainland.. On May 5, 1919, a set of two glossy white eggs, 1.28 × .97″ and 1.25 × .97″, was taken on Estate Constitution Hill. The nest is a platform of sticks, usually better constructed than that of the White Crowned Pigeons.

57. *CHAEMEPELIA PASSERINA TROCHILA* (Bonaparte). Porto Rican Ground Dove. Local Name, "Ground Dove".

Resident. Occurs in large numbers on all parts of the island. Breeds in May and June. A nest of fine sticks, unlined, with two glossy white eggs, .84 × .66″, and .88 × .66″, was found June 14, 1921, situated four feet above the ground on the branch of an acacia.

58. *OREOPELEIA MYSTACEA MYSTACEA* (Temminck). Bridled Quail Dove. Local Names, "Partridge", and "Wood Dove".

Resident. Once a common bird in the heavy woods of the North Side, but now close to extinction. Sept. 10, 1923, I shot an immature bird which had not been long out of the nest, as the soft bill, broad at the base, indicated, and I believe it flushed from a nest as I forced my way through the heavy underbrush. The mongoose is solely responsible for the decrease in the numbers of this species.

59. *COCCYZUS MINOR TERES* (Peters). Mangrove Cuckoo. Local Names, "Cat Bird" and "Cow Bird".

An abundant species, having a general distribution. Their nests are difficult to locate. A set of two pale sky blue eggs collected Feb. 10, 1922, measured 1.25 × .94″; and 1.19 × .94″. I waited ten days before taking these eggs to give the female time to deposit others, but apparently this was the full complement. The nest was a bulky platform of coarse sticks placed eight feet above the ground on the horizontal branch of a "ginger thomas" tree.

60. *CROTOPHAGA ANI* (Linné). Ani. Local Name, "Black Witch".

Resident. Common on all parts of the island except the heavily wooded areas. Its breeding habits are irregular. A set of seven eggs was collected Nov. 17, 1921 from a nest occupied by a single

pair of birds. The nest was well constructed of coarse sticks, having a deep, unlined cavity. The eggs were greenish blue in color, with a white chalky coating, scratched in several places.

61. *GYMNASIO NUDIPES NEWTONI* (Lawrence). Newton's Owl. Local Name, "Kookoo bird".

Newton's Owl. Local name, "Kookoo bird". I have come to the conclusion that this species is now extinct on the island, after years of fruitless efforts on my part to obtain, or even hear, a single specimen. Thirty years ago it must have been a fairly common bird in its restricted area, the heavily wooded areas of the North Side. All the native "old-timers" who have been living in that vicinity all their lives are familiar with the little "kookoo-bird", as it is known to them. In 1923 I was taken to a very old "thibet tree" which was nothing more than a living shell. About twenty feet up there was a large hole in the side. Pointing at the hole, the aged cattle herder, who is still alive and living in the "village" at Little Fountain Estate, where he was born, said to me, "A pair of kookoo-birds used to live in that hole, and I used to hear them bawling in the night." Then I asked him what the "bawling" sounded like, and he anwered "koo-koo, koo-koo", hence the local name. Then I enquired, "how many years, about, since you remember seeing or hearing the last koo-koo bird?" Taking a hold of his heavy jaw with his roughened hands, he was thoughtful a moment, then calmly answered, "Boss, it must be done gone over eight or ten years." I passed the word along among the North Side Villagers, that the person who could give me information leading to the capture of a "koo-koo bird" would be rewarded with five dollars. The offer still stands, but no owls.

62. *ANTROSTOMUS CAROLINENSIS* (Gmelin). Chuck-will's-widow.

Regular winter visitant. Nov. 9 (1); Nov. 12 (2), at Constitution Hill Estate. Jan. 1 (1); Jan. 16 (2), in the North Side Woods. Two specimens collected. Uncommon.

63. *ORTHORHYNCHUS EXILIS EXILIS* (Gmelin). Gilt Crested Hummingbird. Local Name "Doctor Bird".

Resident. Not so common as the larger species, and prefers the dense undergrowth of woods to the open country. A nest, made of cotton adorned with lichens, was taken Feb. 25, 1920, and was placed two feet above the ground in the crotch of a mahogany seedling. The two white eggs measured .44 × .31", and .50 × .31".

64. *SERICOTES HOLOSERICEUS HOLOSERICEUS* (Linné). Blue-breasted Hummingbird. Local Name, "Doctor Bird".

Resident, found everywhere, and on the neighboring islets. A nest with two white eggs was taken July 1, 1929 from a mahogany tree. The nest was made of cotton adorned on the outside with lichens. It was placed eight feet up, at the crotch of small horizontal branch. Eggs .54 × .41", and .56 × .41".

65. *STREPTOCERYLE ALCYON ALCYON* (Linné). Belted Kingfisher.

Regular winter visitant. Sept. 10 (1); Oct. 9 (4); Nov. 27 (6); Dec. 18 (6); Jan. 1 (2); Feb. 25 (1); Mar. 30 (4); Apr. 9 (3); May 1 (1). Frequents all the lagoons and ponds on the islands.

66. *SPHYRAPICUS VARIUS VARIUS* (Linné). Yellow-bellied Sapsucker.

Jan. 3, 1924, I shot a female from the branch of a "giant thibet" tree on La Grange Estate.

67. *TYRANNUS DOMINICENSIS DOMINICENSIS* (Gmelin). Gray Kingbird. Local Name, "Chichery".

Resident. A very common species, also found on neighboring islets. Breeds in May and June. Aug. 25, 1921, I took a set of three eggs, 1.08 × .78"; 1.08 × .78"; and 1.05 × .78", from a nest which was constructed of fine sticks, deeply cupped and lined with rootlets, placed five feet up, on the branch of an acacia. The eggs were light salmon red, with large and small spots of deep reddish brown and brown, wreathed around the larger end.

68. *ELAENIA MARTINICA RIISII* (Sclater). Riise's Elaenia.

Resident. Increasing rapidly, now common. Ranges over the island and two neighboring islets. A nest found March 17, 1922, contained two eggs, .78 × .63", and .81 × .63", salmon with lilac and brownish spots, wreathed around the larger end. The nest was a frail platform of fine dry twigs, not lined, placed seven feet up on a bed of vines which draped over the top of a sapling.

69. *HIRUNTO ERYTHROGASTER* (Boddaert). Barn Swallow.

Regular transient visitor. Aug. 27 (40); Sept. 1 (12); Sept. 10 (60); Oct. 21 (24); Feb. 29 (30); March 30 (15); May 5 (50); June 5 (24); June 10 (1). Ranges over the island. Specimens collected.

70. *PROGNE DOMINICENSIS* (Gmelin). Caribbean Martin.

George Seaman observed a pair that remained in the vicinity of Estate Lower Love during 1917 and 1918, and evidently nested in a hole in the factory's smokestack. From March to July, 1923, I observed two pairs flying about the smokestack of the Bethlehem sugar factory, and I believe they nested in one of the draught holes 75 feet up.

71. *MIMUS POLYGLOTTOS ORPHEUS* (Linné). Jamaican Mockingbird.

Resident. They are increasing rapidly. Apr. 21, 1919, I collected a set of four eggs, 1.00 × .75″; 1.00 × .75″; .97 × .75″; .97 × .75″ pale bluish green heavily spotted with chocolate and brown, wreathed around the larger end. The nest was composed of coarse sticks lined with rootlets, placed two and a half feet above the ground in an acacia.

72. *MARGAROPS FUSCATUS FUSCATUS* (Vieillot). Pearly Eyed Thrasher. Local Names, "Thrush" and "Sour-sap Bird".

Resident. Very common among the "fruit gardens". June 15, 1921, I surprised a female on her nest, which was constructed of coarse sticks, scantily lined with rootlets, and placed at the bottom of a hole in an alligator pear tree. The three eggs measured 1.30 × .88″; 1.32 × .88″, and 1.30 × .88″, and were spotless glossy deep sea blue.

73. *VIREO OLIVACEUS OLIVACEUS* (Linné). Jamaican Vireo. Local Names, "John-chew-it", and "Greenlet".

Very common summer resident, also found on neighboring islets. They leave in August, returning in December and January, and nest in June. June 11, 1921, I found a nest suspended from the forked branch of a "turpentine" tree, twelve feet above the ground. It was made of soft grasses and cotton. The three eggs were all of the same size (.88 × .63″), and were white with fine blackish spots, wreathed around the larger end.

74. *COEREBA NEWTONI* (Baird). St. Croix Honey Creeper. Local Name, "Yellow-breast".

Resident. Very common, ranging from seacoast to heavy woods. The breeding season is irregular. A nest, examined Sept. 30, 1921, was made of soft grasses and cotton, unlined, and situated four feet up in a sweet lime hedge; it was domed, with the entrance at the

side. The three eggs were all the same size (.69 × .50″), and were white with a salmon tint, finely sprinkled with brown and chocolate.

75. *MNIOTILTA VARIA* (Linné). Black and White Warbler.

Regular winter visitant. Sept. 10 (4); Oct. 6 (8); Oct. 8 (6); Jan. 1; Jan. 6 (3). Not common, and keep to wooded localities. Specimens collected.

76. *COMPSOTHLYPIS AMERICANA PUSILLA* (Wilson). Northern Parula Warbler.

Regular winter visitant. Sept. 30 (4); Nov. 6 (12); Dec. 30 (20); Jan. 1 (25); Apr. 1 (30); Apr. 23 (30); Apr. 28 (1); Apr. 30 (10). Very common. Found in the woods, but more common in the sage brush. Specimens collected.

77. *DENDROICA TIGRINA* (Gmelin). Cape May Warbler.

Regular winter visitant. Sept. 8 (1); Nov. 14 (4); Dec. 11 (4); Dec. 30 (2); Jan. 1 (8); Feb. 10 (1); Feb. 23 (4); Apr. 19 (1). Uncommon. All these observations were made around Constitution Hill estate, where the birds kept to the open. Specimens collected.

78. *DENDROICA PETECHIA CRUCIANA* (Sundevall). Golden Warbler. Local Name, "Canary".

Resident. Rarely met with in wooded areas, preferring the open brush lands and mangrove bordered ponds and lagoons. Nests in May. A set of three eggs taken May 13, 1919, was white, with a greenish tint, spotted with blackish and gray, and wreathed around the larger end. The eggs measured .72 × .56″; .75 × .56″ and .75 × .56″ The nest was made of grass and lined with softer grasses, deeply cupped. It was placed three feet up in a "sage" bush.

79. *DENDROICA VIRENS VIRENS* (Gmelin). Black Throated Green Warbler.

Collected a male and female, Oct. 18, 1919, which were feeding on small green and brown caterpillars on a big "flamboyant" tree on Constitution Hill.

80. *DENDROICA DISCOLOR* (Vieillot). Prairie Warbler.

Regular winter visitant. Sept. 1 (10); Sept. 7 (25); Dec. 30 (1); Jan. 1 (20); Apr. 1 (30); Apr. 23 (25). Common. Found in the woods, but more abundant in the sage brush and open country. Specimens collected.

81. *DENDROICA PALMARUM PALMARUM* (Gmelin). Palm Warbler.

Regular winter visitant; common. Oct. 6 (10); Oct. 16 (1); Oct. 20 (4); Jan. 1 (20); Feb. 23 (1); Apr. 30 (1). Confine themselves to the open country.

82. *SEIURUS NOVEBORACENSIS NOVEBORACENSIS* (Gmelin). Water-thrush.

Regular winter visitant. Sept. 1 (4); Sept. 5 (6); Sept. 18 (10); Nov. 24 (20); Jan. 1 (15); Mar. 20 (10); Apr. 14 (10). Common along streams, ponds and lagoons. Specimens collected.

83. *SEIERUS AUROCAPILLUS AUROCAPILLUS* (Linné). Ovenbird.

Regular winter visitant. Sept. 15 (4); Dec. 30 (20); Jan. 1 (20). Common in the woods.

84. *WILSONIA CANADENSIS* (Linné). Canadian Warbler.

Feb. 17, 1924, I startled a cock of small birds that were feeding among the scrub mangroves bordering the Salt Pond. Following them for quite a distance I finally succeeded in obtaining a male which was in perfect plumage. There were about ten altogether.

85. *SETOPHAGA RUTICILLA* (Linné). Redstart.

Regular winter visitant. Sept. 1 (6); Sept. 7 (4); Dec. 30 (3); Jan. 6 (5); Apr. 1 (1); Apr. 23 (15). Common in the woods, seldom seen in the open country. Specimens collected.

86. *HOLOQUISCALUS NIGER BRACHYPTERUS* (Cassin). (Lawrence). Porto Rico Blackbird.

Introduced from Porto Rico about 1917 at the "Whim" Estate, where they appeared to be doing very well, nesting in the large "thibet" trees around the proprietor's mansion. Nov. 10, 1919, a pair had wandered as far as estate Constitution Hill.

87. *PIRANGA ERYTHROMELAS* (Vieillot). Scarlet Tanager.

Shot a male Apr. 20, 1919 which was feeding among the branches of a "turpentine" tree growing on the grounds of Peters Rest Public School. Perfect adult plumage.

88. *TIARIS BICOLOR OMISSA* (Jardine). Garib Grassquit. Local Names, "Sin-bird", and "Sparrow".

Resident. Common everywhere excepting the heavy woods. Irregular nesting season. A nest and three eggs were collected Sept.

25, 1923. The domed nest was made of soft grasses, not as compactly woven as the nest of the Honey Creeper, and placed three feet up in an acacia. The entrance was at the side. The eggs measured .69 × .53″; .69 × .53″, and .72 × .53″. The ground color was light grayish white, and they were sprinkled with dark brown, especially around the larger end.

A NEW LEAF-MINER OF COTTON IN PORTO RICO

(NEPTICULA GOSSYPII new species)

By W. T. M. Forbes [1] and M. D. Leonard [2]

Introduction

On March 6, 1930 a small cotton field was found near Juana Díaz in which the leaves were severely infested by a leaf-miner. A minute moth which appeared black-and-white banded to the naked eye, was noticed on a number of the leaves and judged to be associated with the trouble. Facilities were lacking at the time for collecting and preserving specimens, but a quantity of the mined leaves were gathered.

During the course of that day and the next, a number of cotton fields were carefully examined in the vicinity of Ponce, Tallaboa, Yauco and Sabana Grande, and the leaf-miner was found to be present in all, with one or two exceptions, in greater or less numbers. Most of the mines seemed to be empty and moths were not again observed, though they are so small as to have been easily overlooked.

On March 8th several fields of cotton were examined in the vicinity of Arecibo and Camuy on the North Coast. The cotton here was all young, being only a few inches high. Two or three leaves only were found showing a small mine or two apiece.

Upon reaching the laboratory in Río Piedras on the 10th it was found that the leaves had either badly moulded or had dried. Three greenish lepidopterous larvae, however, were dissected from the end of fresh mines and one naked pale greenish pupa was found on the surface of a leaf. These all died in a day or two.

No reference to a leaf-miner in cotton could be found in literature available nor any record of such in the files of the Insular Experiment Station. Nor was a leaf-miner mentioned in the paper on "Cotton Insects of Porto Rico" by E. G. Smyth, Ent. News 31: 121–125, 1920.

Further opportunity to collect additional material did not present itself until April 5th, 1930 when in company with Dr. J. G. Needham of Cornell University a field of cotton was visited near the one first-mentioned near Juana Díaz. The work of the leaf-miner was ex-

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ceedingly abundant but all the mines examined were empty and no moths could be found. Another field just north of Villalba was found to be much more lightly infested but here three or four mines were found containing larvae.

From these two fields a considerable number of leaves was brought back to the laboratory. It was not possible to examine them carefully until the 8th. On this date a number of cocoons were found, mostly on the lower surface of the leaves, and three or four larvae were dissected from the mines. The cocoons were confined in shell vials and on the 15th eight moths were found, a couple of these undoubtedly having emerged the day before, since they were already dead. On April 16th four more moths had emerged and on the 17th three additional adults were obtained.

Further field observations were made in two cotton fields on April 18th near Guayanilla. In one, a dry field where no new leaves were being put out the mines were old and apparently all deserted. Every leaf examined, however, had been infested, many having numerous mines. In the other field the plants were producing new foliage. Here the condition of the old leaves were as in the other field: the new leaves showed a moderate number of fresh mines.

Food Plants and Origin

The cotton referred to in this discussion is all Sea Island cotton (*Gossypium barbadense* L.). This type is being increasingly grown commercially in Porto Rico and is found by many farmers to be a profitable crop, especially desirable in some cases as a substitute crop on land which will not produce a profitable crop of sugar-cane. There was during the growing season of 1929–1930 about 14,000 acres of Sea Island Cotton in Porto Rico, divided between about 4,000 acres on the South Coast and about 10,000 on the North Coast.

On April 24 and again on May 20 a number of fields were examined on the North Coast throughout the length of the cotton growing belt. Altho by the latter date a number were well along towards maturity and the plants large no evidence of the presence of the leaf-miner could be found. On May 21st several fields were examined on the South Coast. The plants were all old and the crop had apparently matured and been for the most part picked. Abundant evidence was present of earlier infestation, but even where green, fairly new foliage was present, no new infestation could be found. The same condition obtained about ten days later. Apparently there

is a distinct season of activity and non-activity of the insect in relation to the cotton on the South Coast.

Casual search on tree cotton (*Gossypium hirsutum* L.) has failed so far to disclose evidence of this leaf-miner on the Island of Porto Rico. On April 30th, however, we examined several tree cotton plants near Puerto Real on Vieques Island. One leaf had a small mine which appeared to be characteristic of this species. We have as yet had little opportunity to search for it in other species of *Gossypium* known to occur in Porto Rico, or in other Malvaceae of which there are several species occurring here.

It cannot be determined at present whether this leaf miner is indigenous to Porto Rico or not. So far as we can ascertain, no Nepticula has yet been recorded from the West Indies, and no Nepticula has yet been bred from cotton in any part of the world. It seems unlikely that an insect whose work is so conspicuous on a crop that has been so carefully observed by official entomologists in the past, should have been entirely overlooked, so there is a possibility that the species has recently come over from some other Malvaceous food, or from some other part of the world. The two-banded species of Nepticula seem to be most characteristic of the New World, however, and the probability is that the species is actually indigenous to the Antilles or to Central America. It should be sought for in the other cotton growing areas of this zone, especially in regions where cotton is grown in small amounts or semicommercially among native vegetation.

Description of the Stages

THE EGG (PL. XV, FIG. 6)

Unhatched eggs have not been found, but the egg-shell is as follows: about .17 mm. in length and about .14 mm. at greatest width; broadly elliptical, somewhat convex on free surface, shining, translucent white, and without noticeable sculpture under the high power binocular.

THE LARVAE (PL. XV, FIG. 2)

Length 2.5 mm.; green with the chitinized parts of the head pale brownish; somewhat flattened; the legs represented by high conical projections or lobes on the meso- and metathorax and on the 2nd to 7th segments of the abdomen; first and last 3 abdominal segments noticeably reduced in size; the structure of the head and the arrangement of the setae are as usual in the family.

THE PUPA (PL. XV, FIGS. 4 AND 5)

Length, 1.3–1.5 mm.; color pale green, the abdomen somewhat darker, without markings; cuticle thin, soft and transparent; of a modified incomplete type, stout and flattened; wings and hind legs reaching to end of body; antennæ half as long; tongue rudimentary; appendages soldered but not strongly so, with all their parts easily recognizable; prothorax much narrower than head in dorsal view; abdominal segments effectively immovable; no obvious setae or spines except on the last segment which has a larger anterior pair of projecting teeth and a smaller posterior pair; last abdominal segment truncate and slightly bifid behind; middle abdominal segments each with a transverse row of spiracles, only distinctly visible on the cast pupa-shell; scape very large, covering the eye except a small ventral portion; maxillary palpi conspicuous, transverse, extending behind the eye from antenna to maxilla; labial palpi short, completely exposed, the short tongue and labial palpi leaving the ventral surface of the body largely exposed.

THE COCOON (PL. XV, FIG. 1)

About 1.8 by 1 mm. White, oval, flattened, strongly narrowed to the posterior end where it is stained by a brown dot of the last frass; broadly rounded at the anterior end, where there is a horizontal slit its whole width, for the emergence of the moth, closed before emergence by a few silk threads. The cocoon usually bulges on one side more than the other.

THE ADULT (PL. XV. FIG. 3)

Expanse 2.8 mm. Black, with a slight purple irridescence. Head cream color, including palpi, occiput and eye-caps; tuft deep ochre or dull tawny. Antennae fuscous. Fore-wing with two pale-gold fasciae, the more basal one somewhat darker and slightly less iridescent, twice as wide on inner margin as on costa, and with its outer boundary somewhat offset on the fold (see figure); second fascia somewhat widened to inner margin and slightly constricted at middle of wing, slightly wider than first fascia at costa, but much narrower at inner margin. Apex more shining, occasionally appearing silvery in a favorable light. Fringe about apex with a black basal line, the outer part nearly white and strongly contrasting, dorsal fringe mouse-gray. Hind-wing light gray with mouse-gray fringe. Thorax lead-gray, the tegulae somewhat darker. Abdomen fuscous.

We have come across no description of an old-world Nepticula that could be confused with this. In Miss Braun's key[3] it will run most nearly to *N. bifasciella* Clemens, from which it will differ by the fact that the ground of the fore-wing is all of one color, and by the much smaller size. The two bands of *N. epicosma* Meyrick '15, from South America, differ in position.

Type locality. Juana Díaz, Porto Rico, Holotype and eight paratypes, Cornell University, type No. 948.

THE MINE (PL. XVI)

Slender, sinuous, but if straightened out would be on the average rather more than 25 mm. in length; ends in the usual slight enlargement with a crescent-shaped emergence hole on under surface of the leaf. In the first half of the mine the frass is arranged in a zig-zag line of arcs, each arc being composed of half a dozen dots. In the latter half of the mine this changes over into a single continuous line of fluid frass; the transformation being either abrupt or gradual. In weathered mines the zig-zag first portion of the frass line tends to disappear. The mines cross each other freely and infrequently run into each other.

In fresh leaves on the plant the mines are almost invisible on the upper surface but when the lower surface is examined they may be readily traced since their surface is noticeably raised and in the older portions the mines are slightly reddish or purplish. When the leaves become old and dried the mines become whitish in marked contrast to the darkened leaf surface and are then especially conspicuous on the upper surface.

Life-History

Pressure of other work and lack of sufficient opportunity to rear moths in confinement have not as yet permitted us to determine the full life-history of the cotton leaf-miner. Some information has however been accumulated.

The eggs themselves have not been found but the egg-shells could be readily located under a high power binocular by tilting the leaves slightly towards the sun-light when they then appeared on the lower surface as tiny glistening dots. This simple method of locating Nepticula eggs was suggested by Prof. C. R. Crosby of Cornell University in his bulletin on the plum leaf-miner, *Nepticula slingerlandella* Kearfott, (Cornell Univ. Agr. Exp. Sta. Bul. 308, 1911). Egg-laying

[3] Nepticulidae of North America. Trans. Am. Ent. Soc. 43: 155, 1917, largely reprinted in the "Lepidoptera of New York", Cornell Univ. Agr. Exp. Sta. Memoir 68: 84–86, 1923.

has not been observed but probably takes place in the evening or at night as is the case with several lepidopterous leaf-miners, including the coffee leaf-miner (*Leucoptera coffeella* Guérin) and probably with the plum leaf-miner. The eggs are laid singly on the undersurface of the leaves, and as far as observed in the fork of two veinlets, a portion of the edge of the egg often being somewhat concealed beneath the veinlet, so closely is it applied to the veinlet. A small blackish dot of frass can usually be seen within the empty egg-shell. The larva upon hatching apparently enters the leaf tissue directly thru the surface of the egg-shell next to the leaf since no break in the chorion is noticeable on the side away from the leaf surface. The mine undoubtedly starts at the egg-shell but is usually indistinguishable for a short distance away from it.

In the laboratory where infested leaves have been confined in jars or boxes, the larvae, when full-grown, have always formed their cocoons on the leaves. These have been attached usually to the underside against a vein and so firmly as to permit dissecting out the pupa with a single needle without tearing the cocoon loose from the leaf. It may be that in nature pupation takes place in the soil. We have been unable to find cocoons on the leaves in the field even in heavily infested cotton. As further evidence of this possibility two or three naked pupae have been found on the surface of a leaf in the laboratory. The length of the pupal stage is apparently about a week to ten days; or at least that is the time elapsing from the formation of the cocoon to the emergence of the adult.

When ready to emerge the pupa works its way forward, splitting the very thin silk at the anterior end of the pupa about one-third the way down. The empty pupa shell projects slightly from the cocoon. Emergence apparently takes place in the early morning, since the moths were found only in the morning in the shell vials in which pupae had been confined and never by late in the afternoon.

Parasites

Several specimens of a black and of a yellow Chalcis fly have been observed on leaves confined in the laboratory and infested with this leaf-miner. They undoubtedly are parasitic, although this point has not yet been definitely established. The leaf-miner is easily susceptible to parasitism in the mines and undoubtedly further observations will establish parasitism since the coffee leaf-miner also seems to be readily parasitized in Porto Rico.

Economic Importance

During the three months this leaf-miner has been under observation it has not been difficult to find cotton fields of one to several acres in extent in the southern part of the Island in which almost literally one hundred percent of the leaves have been infested. Some of the younger and smaller leaves will contain but a single mine while many older and larger ones may have many mines. Apparently, however, little premature shedding of the foliage occurs even on plants which are severely infested. It must be regarded therefore at the present time as merely a minor pest of cotton but of possibly greater potential importance in the future. It is difficult to believe, however, that as considerable infestations as have been observed should not interfere to an appreciable extent with the proper functioning of the leaves with consequent reduction in size and quality of the crop.

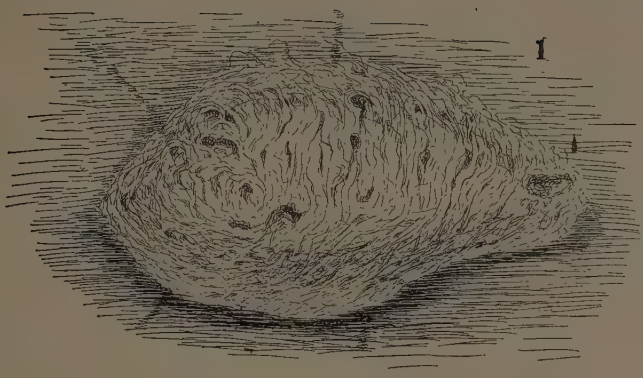
Should the insect assume sufficient proportions at any time in the future so as to make remedial measures seem worth while one or two thoro applications of nicotine sulfate ("Black Leaf 40"), 1 part in 800 parts of water, directed against the underside of the leaves would undoubtedly kill a large proportion of the larvae in the mines. This material is used very successfully for the control of the coffee leaf-miner, *Leucoptera coffeella* Guérin, in Porto Rico in the seed beds. In order to cheapen the cost of the spray as far as possible a considerably greater dilution of the nicotine sulfate could undoubtedly be used by adding a sufficient quantity of Penetrol, a recently discovered very effective activator for nicotine.

Explanation of Plates

Plate XV. (All greatly enlarged)
Fig. 1 Cocoon.
Fig. 2 Full grown larva, side view.
Fig. 3 Moth.
Fig. 4 Pupa, ventral view.
Fig. 5 Pupa, dorsal view.
Fig. 6 Egg.

Plate XVI. (About three-fourths natural size)
Cotton leaves showing old, weathered mines on upper surface.

PLATE XV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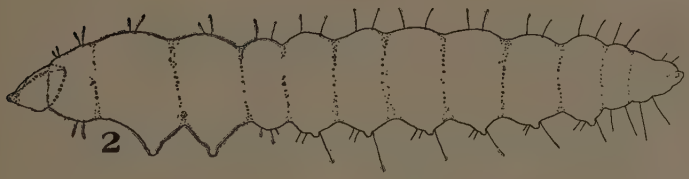
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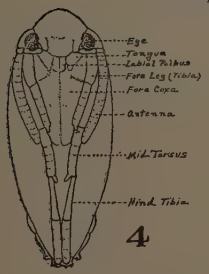
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Tongue
Labial Palpus
Fore Leg (Tibia)
Fore Coxa
Antenna
Mid. Tarsus
Hind Tibia
4

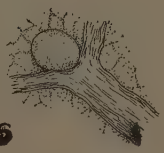
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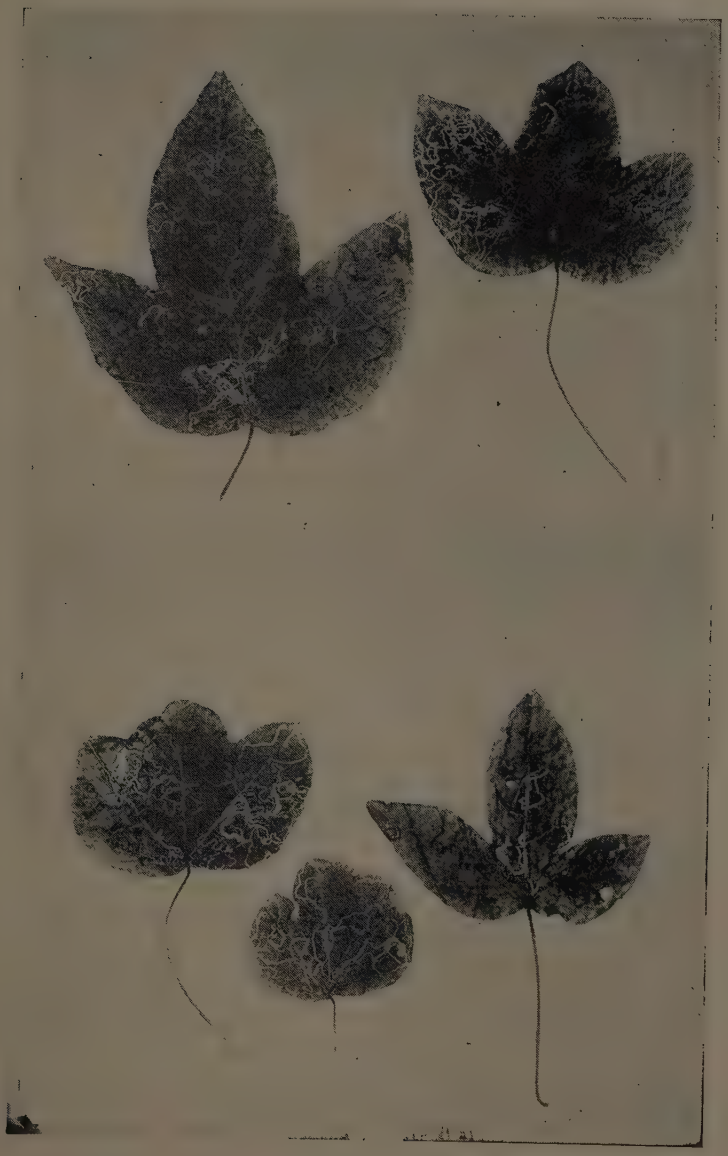
PLATE XVI



A LITTLE-KNOWN ROOT-WEEVIL OF CASSAVA

(COELOSTERNUS SULCATULUS BOHEMAN)

By Mortimer D. Leonard

Introduction

Under date of March 5, 1930, roots of cassava, or yuca as it is locally called, infested with a weevil were received from Mr. I. L. Torres, Director of Extension of the Insular Department of Agriculture. These had been sent in by Mr. J. B. Román, Agricultural Agent at Comerío, accompanied by a letter saying that he had personnally seen the planting and that appreciable damage had been done to it.

An adult weevil which had been dug out of the roots accompanied the specimens and several larvae were found in the roots. Subsequently two or three more of the adults emerged.

Specimens were submitted to Mr. Chas. W. Leng of the Staten Island (New York) Public Museum who replied that he and Mr. A. B. Mutchler of the American Museum of Natural History were unable to place the species. They therefore submitted it to Dr. Guy A. K. Marshall of the British Museum who determined it as *Coelosternus sulcatulus* Boheman, with the statement that it was originally described from Guadeloupe and had previously been represented in the British Museum by but a single specimen.

On March 21, in company with Messrs. Torres and Román the writer visited the farm where the weevil had been found. It is owned by Don Pedro Tañón in the Barrio of Doña Elena and is at about 1,800 ft. altitude, an hour by horseback up in the mountains. There had been about 2 acres planted in cassava which had been recently dug, the entire plants having been laid aside to dry out. From personal examination and from conversation with the grower we estimated that about 10 per cent of the roots were worthless altho the actual percentage of plants infested was somewhat higher than that. A new planting had been made and the shoots were just beginning to show above ground but we were unable to find any weevils or larvae in or near the "seed" pieces altho they were close to the old planting. The grower stated that he had not previously observed such damage, altho he had grown yuca for several years. We were unable to learn from where he obtained the

"seed" for the original planting on his farm but presumably it was from some nearby plantation, since cassava has been grown in that section for a considerable length of time.

The only reference I have been able to find to a weevil infesting yuca is by R. S. Cunliffe (Yuca, Su Cultivo, Variedades, Contenido en Almidón y Fabricación. Cuba Est. Exp. Agron. Bol. 34: 57–58, 1916) who states that in the island of St. Vincent a species of Cryptorynchus has been found as a stem borer [taladrador del tallo]. I have, however, been unable to locate the original in any of the reports of the St. Vincent Department of Agriculture upon which Cunliffe must have based this statement. Furthermore F. W. Urich in a paper entitled Cassava Insects in Bul. Dept. Agr. Trinidad and Tobago 14 (2): 38–40, 1915, gives records of cassava insects in other countries but makes no mention of this weevil in referring to the pests of the crop recorded from St. Vincent.

History and Distribution

Coelosternus sulcatulus Boheman was first described in Carl J. Schoenherr's "Genera et Species Curculionidum", IV (I): 220, 1837. The locality is given as Guadeloupe. The number of specimens upon which the original description was based is not stated. With the exception of the specimen in the British Museum it has not since been noticed until found last March in Porto Rico. Altho since that time several plantings of yuca in the vicinity of Río Piedras and to the West along the North Coast to Arecibo have been examined, no further infestations have been found. It is possible that the species has become established in the higher altitudes in the Island but inquiry among the Agricultural Agents has so far failed to bring any further report of its presence.

Food-Plant and Nature of Injury

Cassava or yuca, *Manihot Manihot* (L.) Cockerell, is generally grown throughout the Island in small patches of usually an acre or two or even less. Altho none is grown for the commercial production of starch it forms an important source of food for the natives who eat the edible storage roots.

Strictly speaking it is not the roots themselves but the underground part of the stem in which the larvae feed. The plants found infested near Comerío had the basal, woody part of the stem which lies immediately underground and usually parallel to its surface, tunneled by the grubs. Altho the larvae do not feed in the storage

roots, injury to the underground part of the stem weakens the whole plant and reduces the size and quality of the storage roots.

Description of Stages

THE LARVA (PL. XIX FIG. 3)

Length about 10 mm., body strongly curved; yellowish-white to pale brownish yellow with head capsule reddish brown, mandibles blackish.

Some of the more important features of the larva appear to be as follows: body strongly curved, the first, second and third abdominal segments being slightly smaller than the remainder and than the thoracic segments, giving the body a somewhat constricted appearance at the middle. A large, elongate spiracle on the prothorax, about three times the length of the abdominal spiracles which

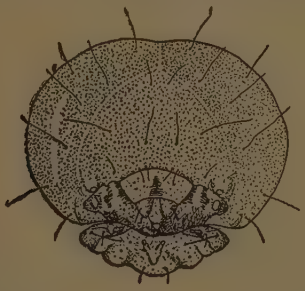


Fig. A.
Head of Larva

are distinct and of moderate size, that of the eighth segment being uniform in size and shape with the others. Body glabrous except for the pale hairs found on each segment which are very fine, short and sparse. The eighth segment bears a pair of well developed setae towards the median line at about two-thirds of its length caudad when viewed laterally, from which point it slopes sharply to the caudal border; a well developed seta is located on each side on a prominent protruberance caudoventrad of the spiracle. The ninth segment is much smaller than the eighth and only about one-half its width viewed laterally; it bears one set of setae on either side. The tenth segment is very small and glabrous and is neither dorsal nor ventral but more nearly terminal, the tip being just visible in lateral view protruding beyond the border of the ninth.

The details of the mouth-parts (as far as could be determined) and of the arrangement of the setae on the head are as shown in text figure A.

THE PUPA (PL. XVIII FIGS. 1 AND 2 AND PL. XIX, FIGS 1, 2, 4)

(Description drawn up from one specimen nearly ready to change to an adult and therefore brownish yellow with abdomen and parts of head dark brownish.)

Length, about 12 mm. At first whitish, later becoming yellowish to brownish yellow as development advances.

A prominent thoracic spiracle is located at the base of the prothorax. The beak has two transverse depressions just apicad of the antennae. There are seven prominent setae on tubercles on the head one on either side of the median line near the vertex and a transverse row of five just above the eyes, the middle one being just to the left of the median line. The frons bears two median setigerous tubercles. On the beak are setae on tubercles, but somewhat smaller, three on each half (viewed from in front); just above the base of the antennae, and near the tip of the beak are two more, still somewhat smaller.

The prothorax when viewed from above is almost twice as wide as long, rounded in front and about one-third the way caudad swelling laterad to about twice the width. The basal angles are slightly extended backwards and the caudal border is extended caudad at the median line into two small protruberances thus giving the caudal border a sinuous outline. The prothorax bears eight pairs of prominent setigerous tubercles one apical and one subapical, one antero-median and one antero-lateral, three postero-lateral, and one postero-median. There are a number of irregularly scattered spines, somewhat smaller and less numerous towards the middle and hind part of the disc. Mesothorax with two pairs of smaller setigerous tubercles. Metathorax with a median transverse row of three still smaller setigerous tubercles on either side.

The first six abdominal segments viewed dorsally are about equally wide cephalo-caudad, gradually decreasing in width laterally and each with a transverse row of small setigerous tubercles near the caudal margin; the seventh somewhat wider but narrower with a transverse row of larger setigerous tubercles; the eighth still smaller both ways, posterior margin strongly convex and with two prominent median setigerous tubercles; the ninth segment small, transverse, with each postero-lateral angle prolonged into a prominent chitinous process, below each of which is a small setigerous tubercle; the tenth segment is not visible from above but when viewed from below is small and appears to be protruding slightly from the encircling ninth segment; it is apparently glabrous.

Femora each with two prominent subapical setigerous tubercles on outside. Wing-pads extend to about the caudal border of the sixth abdominal segment. Longitudinal ridges on the wings prominent and with numerous small setigerous tubercles.

THE ADULT (PL. XIX FIG. 5)

The adult weevil is 6 to 7 mm. in length. Messrs. Leng and Mutchler have been kind enough to furnish me with a brief diagnosis and with a copy of the original description both of which follow quoted in full:

"Head with a V-shaped raised ridge behind the eyes; coarsely punctate; scaly, scales on basal part smaller than on apical; apical end of the beak smooth shining but beginning on the apical half there are raised ridges, the middle one of which continues back to the base; basal half covered with scales. Scape of antennæ moderately short; funicle seven jointed, second joint longer than the third; club elongate and somewhat thickly pubescent. Pronotum suddenly narrowed at apex and with a prominent raised median ridge on the apical half; coarsely punctate; vestiture consisting of rounded and elongate scales, sides more densely scaly; ocular lobes prominent. Elytra with the alternate striae prominent, intervals coarsely punctate and granulate, vestiture consisting of rounded and elongate scales. Under surface and legs somewhat densely scaly. Femora with two teeth on the apical half the one nearest the apex being the smaller; tibiæ curved and with a curved tooth at the apical end."

"Male, female. 22. *C. Sulcatulus.* Chevrolat.

"Ovalis, niger, dilute fusco-griseo-squamosus; rostro tenui, valde arcuato, basi confertim punctato, carinato; thorace punctatissimo, dorso antico argute carinato; elytris subtiliter bifariam punctato-striatis, interstitis alternis carinatis; femoribus clavatis, omnibus bi-dentatis.

"*Patria:* Guadeloupe. A Dom. Chevrolat amice communicatus. Mus. Schh.

"Magnitudo, statura et summa similitudo *Cryptorhynchi haemorrhoei;* clava antennarum elongata, rostro basi tantum carinato, thorace antice carinato, femoribus omnibus bi-dentatis, ab illo distinctus. Caput breve, convexum, rugoso-punctatum, nigrum, squamis, depressis, fusco-griseis, tectum, vertice linea arcuata praedito; oculi oblongi, haud prominuli, brunnei; rostrum longitudine thoracis, subtenue, teres, valde arcuatum, obscure ferrugineum, basi crassius, ibique supra carinatum, punctatum, squamulosum, de in ex-

trorsum nudum, nitidum, sub-laeve. Antennae in medio rostri sitae, subtenues, dilute ferrugineae, clava elongata, cinereo-pubescente. Thorax latitudine baseos brevior, anterius angustior, apice utrinque emarginatus, leviter constrictus, lateribus valde rotundato-ampliatus, basi bi-sinuatus, supra modice convexus, confertim punctatus, niger, squamulis unicoloribus fusco-griseis dense vestitus, in medio dorsi carinula sat elevata, postice abbreviata, instructus. Scutellum parvum, oblongum, nigrum, punctatum. Elytra antice thoracis basi nonnihil latiora et illi arcte adaequata, humeris obliquis, obtuse sub-rotundatis; a medio apicem versus attenuata, apice ipso conjunctim rotundata, thorace vix triplo longiora, supra valde convexa, postice declivia, punctis parvis, per paria approximatis, squama pallida repletis, striata, interstitiis alternis costatis, alternis planis; nigra, squamulis fuscogriseis dense tecta. Corpus subtus nigrum, crebre punctatum, dense dilute umbrino-squamosum. Pedes longiusculi, validi, nigri, punctati, squamulis dilute umbrinis tecti; femoribus clavatis, omnibus subtus bi-dentatis, dente anteriore valido, posteriore parvo; tibiis nonnihil arcuatis, apice uncinatis; tarsi elongatis, subtus fulvo-spongiosis.—Bhn."

Further Notes

In all, eight adults have been collected or reared, seven of which were on March 5, 17, and 21, 1930. The eighth pupated in its tunnel on about March 30 and the beetle emerged about 3 weeks later, although the adult had remained in the pupal cell for several days before actually emerging from its exit hole in the wood.

Of these specimens four are in the Collection of the Insular Experiment Station at Río Piedras, P. R., and four were sent to Messrs. Leng and Mutchler, one of which is presumably in the British Museum.

The entire length of the pupal cell is about 20 mm., each end being plugged with sawdust to a depth of 5–7 mm. in order to hold the pupa securely in place. The diameter of the cell is about 4 to 5 mm. (pl. XIX, figs. 1 and 2.)

A Longicorn Twig-Borer

On March 5, when the farm near Comerío was visited for the purpose of observing the root-weevil a number of the cassava twigs were found to contain a coleopterous twig-borer belonging to the family Cerambycidae. Unfortunately only one larva and one pupa were preserved so that the specific identity is in doubt. The larva meas-

ures about 18 mm. and is a dirty yellowish white. The pupa is about 8 mm. in length and of about the same color.

Patricio Cardin (Bul. 20 Est. Exp. Agron. Cuba, 1911, pp. 14–17 and 24, Pls. V and VII) has discussed the injuries of two longicorn twig borers in cassava in Cuba. According to notes on file in the Insular Experiment Station, the more common of the two observed by Cardin in Cuba, *Lagochirus obsoletus* Thomas, was determined by Dr. E. A. Schwarz under this name, from a specimen collected at light by D. L. Van Dine on March 26, 1911, in the Condado section of Santurce, P. R. It is listed, however, in Wolcott's "Insectae Portoricensis" (Jour. Dept. Agr. P. R. 7 (1): 110, 1923) under *L. araeniformis* L. This latter species is recorded (1. c.) also from the Central Mercedita, Yabucoa, P. R., Jan. 29, 1913 and from Río Piedras, Apr. 15, 1912 (Van Dine Coll.) and Apr. 18, 1917 (R. T. Cotton Coll.) each from a single specimen collected at light. Presumably Cardin was really working with *L. araeniformis* in Cuba. The species is undoubtedly a cassava feeder in Porto Rico but the pests of this plant have been little studied here. The Comerío material collected by the writer is undoubtedly however not this species, since according to Cardin the full-grown larva of *L. araeniformis* measures about 29 mm. in length.

The second longicorn discussed by Cardin, as a minor pest of cassava *Leptostylus biustus* Lec., is not recorded in Wolcott's List from Porto Rico. It is possible however, that the Comerío specimens may belong to this species since it is apparently considerably smaller than *L. araeniformis.*

EXPLANATION OF PLATES

PLATE XVII.

Section of part of underground cassava stem cut open longitudinally to show tunnels made by the larvae. About natural size.

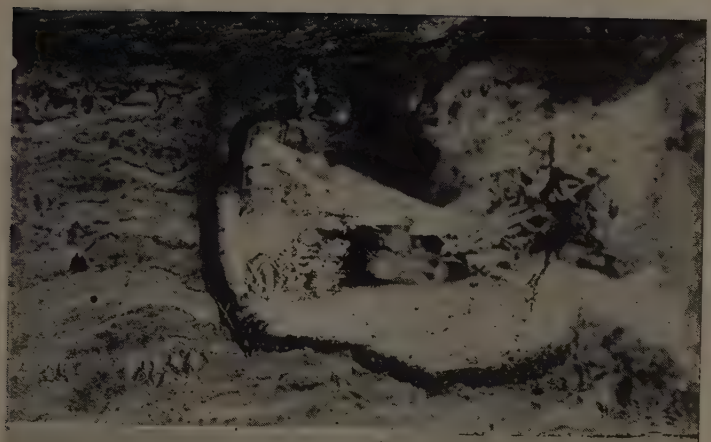
PLATE XVIII.

Fig. 1. Ventral view of pupa in its cell, about twice natural size. Note plug of sawdust at each end.
Fig. 2. Dorsal view of pupa in cell, same size.

PLATE XIX.

Fig. 1. Pupa, ventral view, above 3 × natural size.
Fig. 2. Pupa, dorsal view, about 3 × natural size
Fig. 3. Larva, lateral view, about 3 × natural size.
Fig. 4. Pupa, lateral view, about 3 × natural size.
Fig. 5. Adult, dorsal view, about 2½ × natural size.

PLATE XVII



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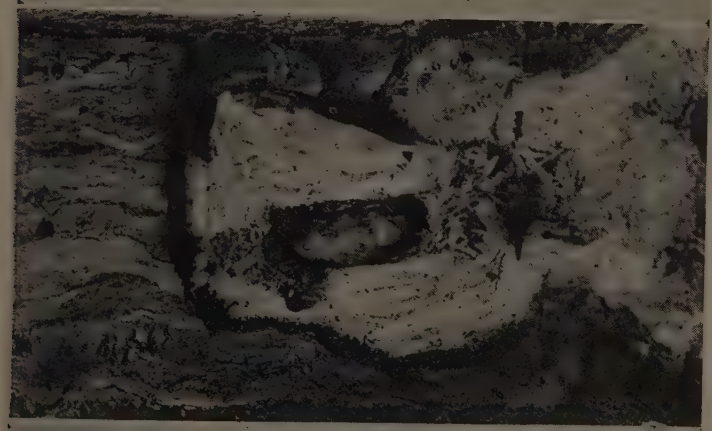
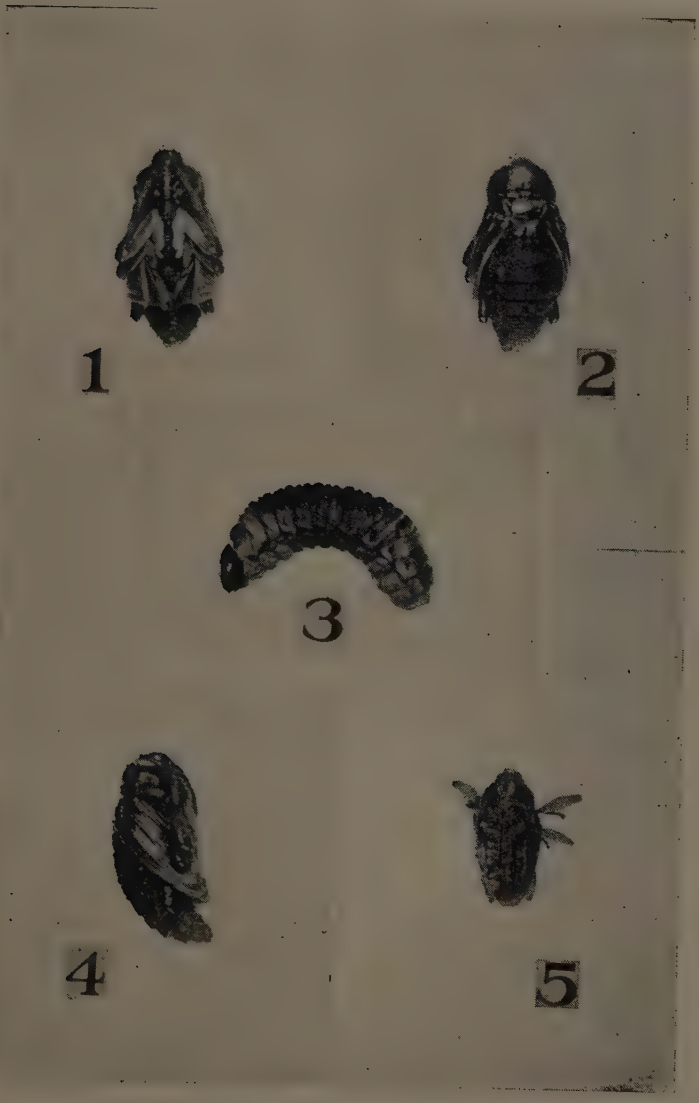


2

PLATE XIX



THE SUGAR CANE ROOT CATERPILLAR [1] AND OTHER NEW ROOT PESTS IN PUERTO RICO [2]

By Francisco Seín, Jr.

Introduction

The sugar cane root caterpillar was discovered by the author on the grounds of the Insular Experiment Station, Río Piedras, Puerto Rico, in the month of November, 1925. The first caterpillar was found above ground late in the afternoon in cloudy, rainy weather. It had the anterior part of its body inserted into a tunnel in the tender part of an aerial cane root from which it was throwing out whitish excrement and upon being disturbed it ran for cover into the soil. Digging in the soil around the cane plant many of the roots were found to have been tunneled, the whitish excrement was observed near the injured roots and several of the caterpillars were collected. They were reared to adult in the laboratory on sugar cane roots.

Systematic History

The adults of this root-boring caterpillar were submitted to the late Dr. H. G. Dyar of the United States National Museum who determined them as *Sufetula grumalis* Schaus (Pyralididæ Pyraustinæ). In the annual report of the Director of the Insular Experiment Station of Puerto Rico for the year 1925–26, a few notes were published on the habits *S. grumalis* abstracted from the Report of the Division of Entomology which latter was not published in full that year. In the Annual Report of the Insular Station for the year 1927–28, in the Report of the Division of Entomology, the author reported that the study of the sugar cane root caterpillar had been carried to a point where it became evident that an error had been committed when it was determined as *Sufetula grumalis* Schaus.

The error is clearly explained by the venation of the fore wing; R_5 is stalked with R_3 and R_4 (Pl. XXVI). The stalk varies somewhat in length as shown in Fig. 20. According to the key given by Hampson, (4) this character makes it impossible to place the sugar cane root caterpillar in the subfamily Pyraustinæ to which the genus *Sufetula* belongs.

The key to the subfamilies of the Pyralididæ given by Forbes (3)

[1] *Perforadix sacchari*, new genus and species.
[2] The name of the Island of Porto Rico has officially been changed to its original form.

is intended to cover New York and neighboring States, U. S. A. If we try to run the Puerto Rico moth by this Key we find that there is no place for it. The first *1* reads: "Vein 1st A preserved in fore wing; tongue weak or absent; fringe on Cu weak or absent: Schœnobiinæ." The second *1*, or the alternative is: "Vein 1st A absent in fore wing."

The Puerto Rican moth has vein 1st A preserved in the fore wing but its tongue is present, well developed and functional. Dr. Forbes' key could be enlarged to take in the new Pyralid by inserting another *1* between the first and second to read as follows: *1.* Vein 1st A preserved in fore wing; R_5 stalked with R_3 and R_4; tongue well developed: Endotrichinæ.

In the key for the subfamilies of the Pyralidæ devised by Hampson (4) for the Old World the Puerto Rican moth runs into the Endotrichinæ, but in the key given by the same author for the genera of this subfamily (5) it does not fit into any but comes nearest to *Diplopseustis.* The author has therefore erected the genus *Perforadix* for the Puerto Rican moth, the description of which follows:

The Genus *Perforadix* new genus, smaller moths, about ⅜ as large as *Diplopseustis minima.*

Labial palpi (Pl. XXVII, fig. 21b) obliquely upturned (in dead specimens may be porrect) the second joint longer than the head, thickly scaled and triangular, the third obliquely upturned and set at upper side of end of second (before apex in *Diplopseustis,* see Pl. XXVII, fig. 21a). Maxillary palpi more than half as large as the labial, third and fourth each very much broadened at tip and triangularly scaled. Eye large. Antennæ simple and ciliate (Pl. XXVII, fig 22). Tongue well developed. Fore wing nearly three times as long as wide, broad at base, obliquely truncate at apex and slightly notched opposite cell. Discocellular vein obliterated, at most only very short stubs. Vein 1st A is a developed tubular vein at margin with interspaces of the normal width between it and the veins above and below it. (Vein 1st A is also present in *Diplopseustis minima.*) Vein Cu_1 almost from angle of cell; vein 3rd A entirely lost. Hind wing with wavy outer margin, the notch a little deeper between veins M_3 and M_2; discocellular vein obliterated; vein Cu_1 from before angle of cell; Rs a short vein between base of M_1 and Sc; R extending to about center of cell and then disappearing; 1st, 2nd and 3rd A faintly marked.

The Type of this genus is the following species:

Perforadix sacchari new species. Wing expanse of 1cm. in the female and 9 mm. in the male. The color varies from dirty cream to a pinkish buff with some smoky shading. Costal edge dark with three half ocellated spots defined with dark bars. Ante- and post-medial lines slightly paler, the ante-medial defined with dark beyond and the postmedial before. Spots at the costa antemedial outly oblique to the fold, strongly innerly oblique and irregular to the edge, the dark edge emphasized on cell fold and inner margins. Outer line (post-medial) nearly perpendicular to opposite cell then oblique to inner margin, the border emphasized with dark towards the inner margin. Ante-post-medial lines emphasized by light and dark at the costa. Some black terminal dots, two at the notch opposite the cell and one at the lower notch more or less emphasized. Discal dot dark, vague and transverse; two or three inconspicuous lines in the fringe. Hind wing with black discal dot, a dark followed by a pale post-medial shade slightly excurved and black terminal dots in fringed edge as in fore wing. Head and thorax concolorous; shoulder slightly darker. Abdomen also concolorous with two or three transverse black stripes. Labial palpi, second segment fuscous outer edge pale, third pale with outer bar at middle. Maxillary palpi with basal half fuscous and remainder cream color. Antennæ of ground color dorsally marked with dark band at scape and at each segment. Legs concolorous, front tibiæ and tarsi barred with black, (Pl. XXVIII fig. 23). In darker specimens the front tibiæ and tarsi may be almost black, in light colored individuals the barring may be indistinct.

Geographical Distribution

According to Forbes (3), the Endotrichinæ are almost entirely confined to the Old World. So far, we only know that *Perforadix sacchari* occurs in Santo Domingo and Puerto Rico and that on the latter it is found in sugar cane fields all over the island.

Food Plant

The roots of sugar cane, *Saccharum officinarum* L. is the only known food of the larva of *Perforadix sacchari*. Half grown larvæ collected in the field among sugar cane roots by the writer have however, been fed for some time on roots of *Gynerium sagittatum* (Aubl.) Beauv; bamboo, *Bambusa vulgaris*, and corn.

The Roots of the Sugar Cane Plant

The work of Venkatraman and Thomas (18) on the roots of the sugar cane plant in India demonstrated the importance of a constant production of new roots for the proper development of the cane plant. These authors have shown how the cane plant under favorable conditions, constantly replaces its root system with a new one and how this constant renovation allows the plant to adapt its root system to changing conditions. When the water table is high, the root system is shallow and when the water table sinks low, the root system becomes deep. From their studies, these authors reached among others, the following conclusion: "To get a good crop the sugar cane should be given facilities for the frequent production of new roots."

Venkatraman and Thomas report a very interesting experiment in which they reproduced artificially conditions similar to those present in sugar cane plantations in Puerto Rico:

> "By a clever arrangement, originally designed by the junior author, it has been possible to grow canes away from the soil, on a definite number of roots and without any possibilities of other new roots developing. Under such conditions the plants gradually lost vigor and died out. When, however, a plant thus starved for fresh roots was given opportunities to develop them, the plant at once grew on in a remarkable manner."

And they repeat the conclusion that "the importance of a continous development of fresh roots in the life of the sugar-cane plant is thus obvious." In the above publication the experiment is illustrated with a color plate. The drying out of the leaves and the stalks when no new roots are produced, and the immediate production of vigorous normal green shoots as soon as new roots are formed is remarkably illustrative of the conditions to be met with in Puerto Rican cane fields. In this Island the hard packed heavy soils do not allow for a constant production of new roots and in addition, the soil animals destroy them as soon as formed.

The Work of the Sugar Cane Root Caterpillar

In most soils the majority of the roots of the sugar cane plant are found in the first twelve inches below the surface. In Puerto Rico the thing that immediately strikes the attention is that the roots are not as long as they should be for their width. If we pick them up and look at them more closely we will see that in the majority of them the tips have been destroyed, that in others the tips have been injured and that there are many neat round holes on

their surface. We will discuss later the other types of injury. Let us now take up the roots whose tips have been destroyed. Those in which the injury is old may show nothing but that the tips have gone, but those in which the injury is more recent, especially if the soil is somewhat dry, will look as if the tips had not disappeared but had been mined out. When pressed between the fingers, these hollow tips feel somewhat like an empty glove finger. Obviously the central cylinder and cortex have been removed leaving nothing but the epidermis. If the soil had been moist, or if the injury were old, we could see that these bits of dead epidermis would have rotted away leaving no indication of how the injury was produced. If however, the soil is not very wet and if there are plenty of fresh roots, some may be found in which the injury is very recent and probably near to it, in the soil we will see piles of whitish excrement and may find the root caterpillar.

By digging in the soil we may not be able to find such a good specimen of the work of the root caterpillar as that shown in (Pl. XX fig. 5, A). Here the root was placed on the surface of the moist soil in a petri dish and to take the photograph after the caterpillar had performed the injury it was not necessary to disturb the root. Otherwise the delicate shell of the very tip and the silk threads which hold it in place would have been destroyed. The entrance hole at B is obstructed with a few pellets of whitish excrement. Here the caterpillar (almost full grown) entered and tunneled into the tip eating out all of its contents. How economical it is of this, the favorite food, seems to be indicated by the silk threads extending from the frail perforated shell to the soil particles as if to facilitate a most thorough consumption. This detail is very interesting when we consider that the supply of root tips is limited and that the destruction of the functional part of the roots will reduce the vigor of the plant and its capacity for further growth and further production of root tips. After tunneling out the tip, the caterpillar tunneled up the root on the other side of the entrance hole. In this upper part the epidermis being stronger required no silk reinforcement. Near to it, the piles of whitish excrement can be seen on the soil lumps. If this root had been injured in the cane fields, and the soil had been somewhat dry, the upper part of the hollow root would be the one we might find later when digging it out.

In the same Fig. is shown another root, C, not as tender and succulent as A. Here a smaller caterpillar worked making the entrance hole as before at a short distance from the tip and laying out some silk threads to hold up the shell of the tip. At D, a more

mature root is shown, the tip of which had been destroyed in the field before it was placed in the dish. Here there was no tip to work on but one of the younger caterpillars tunneled in the cortex. Its pile of excrement can be seen on the side of the root near the tip. Fig. 3 in the same plate shows the appearance of such tunnels extending lengthwise like a furrow after the epidermis decays exposing them.

In the same plate, Fig. 7, shows a main root with side or branch roots. The tip of this root had been destroyed in the field before it was dug out, and as a result of the destruction of the tip succulent side roots had developed. (The three round feeding holes on the main root are not the work of the root caterpillar but of the Symphylid *Hanseniella* sp. as will be explained later.) This photograph shows again at A the typical tunneling of the thick tender root. It also shows another type of root-injury. B and C. were succulent but thin roots and a large caterpillar could not tunnel in them. It therefore ate them off and nothing but parts of the base can be seen. This is what might to called "root severing" and is very interesting as will be seen later when discussing some erroneous explanations that have been advanced by other authors for root tunneling and severing in sugar cane in Puerto Rico.

How far the caterpillar will tunnel inside the roots depends on how tender the roots are. The cortex in cane roots is thin and what the caterpillar eats is practically all the central cylinder. This becomes very tough as soon as the root begins to mature and can not be used as food. Whether the caterpillar will tunnel or eat from the outside depends on the relative size between it and the roots.

Figs. 4 and 6 in the same plate show two views of a full grown caterpillar on a root near the entrance of the tunnel at the tip. This root is somewhat mature but soft enough to be tunneled. The photographs give an idea of the comparative size of a full grown caterpillar with that of a good sized cane root.

Bionomics of Perforadix Saccharl

THE MOTH

The moths of this species usually pass unobserved. They do not leave the cane fields and seldom come to lights at night. During the day time they remain concealed in the trash on the ground and among the dead leaves hanging from the stalks of the cane plants. When startled from cover during the day by beating the trash or dead leaves, they fly back to cover again. When alighting, they run briskly and hide deeply into the trash or cracks and cavities of the

soil. When caught in a net they tend to work their way out through the mesh. At dusk they leave cover and fly about. In the young cane plantations they probably fly low. In the older plantations, where the stalks are tall, and the moths more abundant, they have been observed in flight under the roof formed by the green leaves in a sort of ondulating up and down slow movement among the stalks and dead leaves hanging on them.

The moths have not been observed feeding in the field or alighting on flowers. In the laboratory when confined in vials and petri dishes they extend the proboscis and take up moisture from the soil, leaves or sides of the container. They also take up sugar and honey solutions from bits of cotton seaked in them. In cane fields, however, the moths probably take nothing else but water.

As many as 164 eggs have been laid by one female collected in the fields and kept in a petri dish with moist soil and a bit of moist cotton. The total number of eggs that each female can lay in nature is probably much greater.

THE EGG

The eggs have not been found in nature, but female moths collected in the field were confined in battery jars with moist soil. Bits of trash and cane roots were placed on the surface of the soil. After sun down the moths were observed inserting the ovipositor under the bits of trash roots and lumps of soil and into the cavities and cracks of the soil. The eggs are laid singly or in groups, usually glued to the soil, bits of trash, roots, or to each other (Pl. XXII). The shape of the eggs depends on the space in which they are deposited and how close together they are laid. When laid singly with ample room they are spherical, flattened at the poles and with light furrows running as lines of longitude and latitude. When laid in groups in small cavities they may be bunched somewhat like grapes or even flattened almost like scales. The color is pearly. The incubation period is about 3 to 8 days in April and probably does not vary much during the rest of the year.

THE LARVA

Eggs placed on moist soil in petri dishes in the laboratory have hatched and the larvæ have been raised to adult by furnishing them with fresh tender cane roots. The very small caterpillars make very small feeding holes into the tender tissues. As they grow they take to tunneling. When tender root tips are not available, they may

tunnel in the cortex of the mature roots, between the epidermis and the central cylinder. The very small caterpillars are sometimes found inside their tunnels in the cortex of the more mature roots, but only on one occasion have we found one of the larger instar caterpillars inside its tunnel in a tender root tip. These larger caterpillars remain inside the root only while feeding, living for the rest of the time in the soil cavities.

In nature, the newly hatched caterpillars probably move to the base of the cane plant where tender roots are being produced at the surface of the soil. Thence they reach the tips of the roots following the cracks and cavities of the soil. When all the root tips in one cane plant are destroyed, they seem to move to another plant. The habit of feeding above the surface of the soil on the aerial cane roots in cloudy, rainy weather, that we observed when the insect was discovered, may indicate their ability to migrate from one plant to another above ground. The caterpillars are blind and shun the light, but in cloudy weather, at night, or even during the day time, under the trash that covers the ground in cane fields they may move about freely.

The larval period lasts from 11 to 19 days at the end of which the full grown caterpillar measures 1 centimeter in length and is whitish with brown and light brown plates. (Pl. XXIII, figs. 9 and 10) and (Pl. XXIV, figs. 11–14).

THE PUPA

At the end of its freeding period, the caterpillar moves towards the surface of the soil to pupate in a cell (Pl. XX, fig. 2, A) about half an inch below the surface of the soil. The pupa (Pl. XXV. figs. 15–17) measures from 4 to 6 mm. in length. When reared in the laboratory or collected into vials or petri dishes, if a cell can not be made in the soil, the caterpillars construct a frail cocoon with silk threads and bits of soil, excrement, etc. If enough loose soil is available, the cocoon is constructed with soil particles thus creating a cell. Such cocoons may be formed in nature under the trash in cane fields but we have not found them. The point is of interest because through cultivation to keep the soil loose and preserve moisture, some control might be effected. The pupal stage lasts from 15 to 19 days and during this period the insect is very sensitive to any interference. Breaking up the cell or cocoon or any slight injury to the pupa may be sufficient to kill it.

NATURAL ENEMIES

The only insects found in nature feeding on *Perforadix sacchari* are the larvæ of a subterranean ant. This has been determined by Dr. W. M. Mann as *Cerapachys* sp. While digging in a moist clay loam, a nest of these ants was found in which an immobile and probably dead full-grown caterpillar of *Perforadix sacchari* was lying on its side, partly coiled, while several of the larvæ of the ant were hanging from its sides with their mouth parts attached to its epidermis. Ant larvæ are usually fed by the workers and this habit of directly feeding upon a caterpillar is extraordinary. We have been able to witness it on one occasion only. *Cerapachys* belong to a group of primitive subterranean ants. The condition in which the ant larvæ feed directly upon dead or paralyzed caterpillars is apparently more primitive than the feeding of the larvæ by the adult ants with regurgitated food.

Due to the habit of the adult of *P. sacchari* remaining hidden during the day time, they are safe from lizards and by flying at dusk under the leaves of the cane plant and among the stalks and dead leaves hanging from them they are also safe from bats. Spiders are the only natural enemies that may destroy a few of the adults.

SEASONAL HISTORY

The life cycle of *Perforadix sacchari* is completed in about one month and the generations overlap through the year so that the insect in all its stages may be found in any one place at any time, except in the very young plantations. The roots of the cane plants in such fields, will however be found to be injured abundantly. This is to be explained by the presence of Symphylids, bristle-tails and sow-bugs which work on the roots. When inspecting the roots, it may seem remarkable that the injury is proportionately enormous as compared with the small numbers of soil animals to be found. This will always be the case, and when the plantation is older and plenty of the work of the root caterpillar is to be found, it will also seem out of proportion to the number of insects present.

The explanation of this is that these soil animals move rapidly through the cracks and cavities of the soil and that they are small and soft and easily crushed while digging for them. They never remain close to the injury, but move on to another root-tip for their next meal. When the root-tips become scarce in one plant they move on to another. Thus they may be scarce around the roots of a plant

which are practically all injured and more abundant around the fresh roots of some other plant. In judging the seasonal abundance of the root caterpillar these things must be taken into consideration. The abundance of the insect is dependent on the abundance of root tips. During moist weather, when the food supply is abundant, they will increase in numbers and cause more damage but the economic importance of the damage may be slight. With the advent of dry weather, on the other hand, the number of roots decreases and even though the caterpillars may also decrease in numbers, the economic importance of the damage increases because all of the roots may be injured or destroyed. Some observations seem to indicate that the caterpillars are more abundant during the dry months in the fall of the year, and that the eggs are injured by excessive moisture, but the data on this point are insufficient.

Other Soil Animals to be Considered

Besides the root caterpillar we have mentioned other soil animals which work on cane roots. It is impossible to discuss or estimate the work of the root caterpillar without discussing and estimating the work of these other soil animals which are found always associated with it. Something has to be known about them before we can distinguish between the work of one and the other and estimate the relative importance of each. Because they make cavities in the roots we may call these pests the root boring animals.

THE ROOT BORING ANIMALS

During the course of these investigations on the root caterpillar, the existence of other new root pests of sugar cane has been discovered and the nature, extent and importanc of their damage determined. These new pests have proved to be capable of injuring cane roots when isolated in vials even though supplied with moist decaying organic matter of the types found in cane fields.

The Symphylid, (*Hanseniella* sp., determined by Dr. H. E. Ewing) is the animal that makes the neat round feeding cavities or pits so common in cane roots in Puerto Rico that it is almost impossible to find a single root without them (Pl. XX figs. 3 and 7, Pl. XXI, d). The cavities are also very abundant on the roots of bamboo, *Bambusa vulgaris.* The present tendency is to consider the cortex of cane roots as unimportant and therefore this type of injury as insignificant. We know so little about cane roots that in the future this theory may change, for the cortex, if healthy, protects

and nourishes the central cylinder. The pits made by the Symphylid may open the door to decay. A few of the Symphylid pits may at times be found near the root tips in the tender tissues. In these cases they are injurious and undoubtedly open the door to further damage by other soil animals or decay organism. The work of the Symphylid is of special interest to us because previous to its discovery, we naturally attributed its feeding cavities to the younger instars of the root caterpillar. This was rather annoying because the Symphylid is much more abundant than the root caterpillar and we felt quite baffled in trying to explain the enormous abundance of feeding cavities in terms of an insect which did not seen sufficiently abundant to be considered the logical cause or which at times could not be found at all. Incidentally, we have also cleared up another very interesting point, for Matz (9) in 1925 published a paper with photographs taken in Puerto Rico of feeding cavities or pits in sugar cane roots, quite similar, if not identical with those made by the Symphylid, attributing them to nematodes. This is discussed later and more fully in this paper.

The Bristle-Tails, (*Nicoletia* sp., and *Lepisma* sp.) Another cause for puzzling was the continuous finding of another type of feeding cavities or pits which are larger and not so evenly circular as those made by the Symphylid and not located in the cortex of the mature roots but at or near the tips in the tender tissues. These larger pits (Pl. XXI, e) were not the entrance to tunnels and for a time we attempted to explain them as the work of the larger root caterpillars; but this was unusual because they never developed into tunnels. They were merely feeding pits out of which the tender tissues had been scooped. They could also be found in the roots of bamboo, *B. vulgaris* and *G. sagittatum* on which the root caterpillar does not work.

A large white bristle-tail (*Nicoletia* sp.) found in the soil near the cane, bamboo and *G. sagittatum* roots was isolated in vials and found to be the cause of the larger pits. Another bristle-tail, smaller and golden-brown in color *Lepisma* sp., was also found to produce pits but this latter one is not so abundant as the former. When several bristle-tails in a vial are allowed to work on a root they may make several pits close together or even enlarge some of them, but they never make tunnels. Both bristle-tails have been determined by Dr. J. W. Folsom and are probably undescribed species.

The Sow-Bug (*Philoscia culebræ* Moore). When inspecting cane roots in the fields, sow-bugs are frequently fround in the soil among the roots and sometimes inside the root tips that have been tunneled

out by the root caterpillar. Sow-bugs (undetermined) had once been reported by Van Dine ('17) in 1912 from one locality in Puerto Rico as causing serious damage to cane roots but had never again been considered as possible pests of sugar cane. We have isolated them in vials with soil and decaying organic matter and found them capable of attacking the perfectly sound but tender cane roots. In doing this, they often start at or near the tip eating out irregular shallow cavities. If the sow-bugs are abundant, the cavities may be enlarged and all the surface of the tender root injured. Their injury may also start in otherwise sound roots at some feeding hole made by a Symphylid or bristle-tail in the tender tissues. The sow-bugs get into a pit and enlarge it into an irregular shallow cavity. Inside the tunnels made by the root caterpillar, sow-bugs may continue the injury or merely feed on the decaying epidermis. In the field, sow-bugs are usually found near the surface at the base of the cane stool but it is difficult to determine how much they are feeding on decaying organic matter and injured roots and how much on the tender newly produced roots.

This species has been determined for the writer by Dr. J. O. Maloney of the Division of Marine Vertebrates, U. S. National Museum. It was originally described by H. F. Moore ('10) from two specimens collected under drift on the shore on Culebra Island, P. R. Moore's description has been copied by Dr. Harriet Richardson ('11) in her Monograph of the Isopods of North America.

THE OLD ROOT PESTS

The White Grubs. There are several species of white grubs (*Phyllophaga*) and the larvæ of the rhinoceros beetle, *Strategus titanus*, which attack the roots of sugar cane in Puerto Rico. The rhinoceros beetle larvæ are not common, but the *Phyllophaga* species are found all over the Island and at certain times in some localities are quite abundant and injurious. This is especially true of some localities in the South Coast of the Island. Through the rest of the Island they are always to be met with when digging out cane roots, but ordinarily they are not sufficiently abundant to become important, and many plants will always be found that have not been injured at all by white grubs. The white grubs eat off the roots. They may sever them, or, beginning at the tip, keep on eating until the tender parts are consumed. The injury when not fresh may resemble the work of the root caterpillar, but when fresh there can be no mistake. In the first place, if white grubs are the cause of the injury, they will be found near the roots (they take about nine

months to develop and moved very slowly through the soil). In the second place white grubs can never produce the emptied out root tips characteristic of a root-borer, nor do they produce the piles of whitish excrement. The root caterpillar is found in more or less the same abundance throughout the Island, while white grubs are abundant sporadically and in restricted localities. Very frequently, the work of the root caterpillar (and the other root boring animals) will seem the only possible explanation for the drying out of the cane when no white grubs or indication of white grub injury is to be found. In such situations the roots may be long and apparently normal, but upon close examination the tips will be found to have been destroyed or injured.

The Nematodes and Other Organisms. It is well known that nematodes work on the roots of sugar cane in Puerto Rico causing the characteristic hypertrophies or "clubbing". They are, however, found only in light sandy soils or in light soils with a very porous subsoil and seldom if ever in the heavy clay loams which constitute a considerable percentage of the soils of the Island. Furthermore, even in the light soils, nematodes are ordinarily of little or no economic importance in Puerto Rico.

Matz (9) who studied "root disease" at the Insular Station of Puerto Rico from 1919 to 1922 and then continued his studies in the South Coast of the Island, attempted to explain the feeding cavities or pits found so commonly in sugar cane roots in terms of nematodes. In doing this, Matz's method was purely speculative for apparently he never reproduced the injury experimentally under controlled conditions. He also admits these two contradictory facts: (1) that the pits are found in cane roots commonly all over the Island in the heavy clays as well as in the light sandy soils, and (2) that nematodes seldom if ever occur in heavy clay soils.

But, if pits in cane roots are found all over the Island in all types of soils, the causative organism can not be of limited distribution. The animal which makes the pits must necessarily occur in all types of soil and be proportionately abundant to the amount of injury. The Symphylid, *Hanseniella* sp., answers these requirements. It can be found easily in any cane soil and will produce neat round pits in the cortex of perfectly sound cane roots in vials in the laboratory.

Similar pits are common in sugar cane roots in Louisiana. Matz mentions in his paper that in Louisiana snails were considered to be the cause of the pits. Recently, in 1927, Spencer and Stracener (14) have demonstrated experimentally that the pits in Louisiana

are made by the Symphylid, *Symphylella* sp. A comparison of the photographs of the pits in cane roots caused by the Symphylid *Symphylella* sp., in Louisiana with those attributed to nematodes by Matz in Puerto Rico and with Pl. XX, figs. 3 and 7 and Pl. XXI, d in this paper will show their close similarity.

According to Matz, the gravid females of a nematode living in the cortex of the cane roots caused the cavities or pits which could not become noticeable until the epidermis rotted and the nematode abandoned the cavity. But the pits are frequently to be found near the tender tips in tissues so young that Matz's explanation would be untenable. Thus it seems quite evident that Matz was mistaken in attributing the pits to the work of nematodes. Credit is due to him, however, for having been the first to observe, report and publish photographs of pits in sugar cane roots in Puerto Rico.

The Weevil Root-Borer. The work of the larvæ of *Diaprepes spengleri*—tunneling in the underground parts of the stem or root stalk—is common in certain localities, especially on the South Coast of the Island and the insect is very well known to all. Its common name, however, is inappropriate although very interesting to us because it indicates that those who named it were familiar with a type of root injury—tunneling—which they considered important but the cause of which was unknown. Apparently, in suggesting *Diaprepes* as the cause they were giving it the benefit of the doubt. Thus it has been called the "sugar cane weevil root-borer" or the "root-borer of sugar cane". These terms erroneously convey the idea that there was known at that time some other root-borer of sugar cane not a weevil from which it had to be differentiated, besides leading one to believe that the ability of *Diaprepes* to tunnel or bore in cane roots is a proved fact when actually it is nothing more than a supposition. No one has ever found the larva of *Diaprepes* boring or tunneling in cane roots or determined this ability experimentally. The adults, of course, leave the soil as soon as they transform and practically never eat cane leaves preferring those of bushes and trees on which the eggs are laid glued between two leaves. According to Jones (7):

> "The larvae apparently do not enter the large root-stalks of the cane until some time after issuing from the eggs. During the intervening time they probably feed upon the smaller roots, and it is possible that they do not require living roots altogether, but subsist in part upon decaying vegetable matter. Later they enter the root-stalks making tunnels therein."

The root troubles or "root disease" of sugar cane have been the subject of investigation ever since the Insular Experiment Station

became established in 1910. Investigators of world wide reputation such as Van Dine, Van Zwalluwenburg, Smyth, Wolcott, Johnston, Stevenson, Matz and Earle studied the problem most intensively. Up to the present, there has never been one record of the larvæ of *Diaprepes* found tunneling in cane roots. There is a possibility that if they were responsible for all the tunneling one finds all over the Island, at least one specimen would have been found directly associated with the injury. Instead, we sense in reading their work that all these investigators were continually meeting with types of root injury, (pitting, pruning, severing and tunneling) which they could not attribute to any known organism. Hence the name "weevil root-borer" for *Diaprepes* when it should have been more properly called "root-stalk borer".

As late as 1919, we still find Smyth (13) explaining root tunneling in terms of *Diaprepes* which he calls the "sugar cane root-weevil" without having found the larvæ doing the damage in the fields or reproducing it experimentally in the laboratory.

The Root Mite. In the same year, Smyth (13, 14) reported the mite, *Uropodus* sp. with the common name of "sugar cane root mite" stating that this animal:

> "Eats into, severs, and sometimes tunnels the roots. Damage sometimes serious. This pest was first noted in the Arecibo district . . . and has since been found abundantly at Río Piedras and in other districts. Its damage arises from its attack on the roots which in some cases it tunnels and severs to a considerable degree. Although . . . the roots showing its injury are in many cases diseased and partly decayed, it has been found attacking also healthy roots, so in some cases is believed to be the primary cause of root decay."

Apparently what Symth found was the unknown injury and some mites associated with it, but nothing in Smyth's paper indicates that he ever attempted to reproduce the injury experimentally. In attempting to test whether this or any other mite found associated with cane roots could injure them, the first and main difficulty we have met is the scarcity of the mites. One or two could be found once in a while, but never in sufficient abundance and in constant association with the fresh injury to make them suspicious of it. The very few found associated with decaying roots were not determined, but when isolated with tender sound roots in vials they did not injure them. As an explanation of why they are found occasionally among cane roots Smyth himself in that same paper referring to the *Uropodus* mite, writes: "This animal belongs to a group of mites which possess the habit of attaching themselves to beetles as

means of transportation and distribution." Since *Phyllophaga* and *Strataegus* as well as *Dyscinetus* beetles are found in the soil among sugar cane roots where they hide or go to oviposit, this might suffice to explain why the mites are found occasionally in the same situations. It does not necessarily follow however that they are injurious to the roots. As a matter of fact they have sometimes been considered beneficial when apparently attacking larvæ, pupæ and eggs of *Phyllophaga* and *Stratægus*. They might also possibly attack the root caterpillar.

Diseases Whose Symptoms Might be Confused With Those of Root Injury

Gummosis and Dry Top Rot. Gumming disease or gummosis is caused by *Bacterium vascularum* and dry top disease is caused by *Ligniera* (*Plasmodiophora*) *vascularum* (Matz) Cook. In both diseases the vascular bundles are obstructed by the causative organisms and the products resulting from their activities. This prevents the water and plant food elements from reaching the leaves and the elaborated foods from moving downwards from the leaves into the stalk and roots. The symptoms above ground are the drying out of the leaves, the dying out of the tops and the final drying and dying of the plant. These symptoms might be confused with those of root injury but the existence of the two diseases can easily be determined in most cases. In the first place, some varieties are immune to both diseases and dry top rot is found only in wet soils. In the second place cross sections of the bases of the stalks will show in the case of gummosis the yellow exudations of gum from the bundles, and in the case of dry top rot the orange color of the bundles characteristic of each of the two diseases.

Root Disease. The symptoms of root disease in the stems and leaves would be the same as the symptoms from root injury produced by soil animals and quite similar also to the symptoms of gummosis and dry top rot since in either case the plant suffers because the circulation of water and soil solutions is affected or checked. Root disease is supposed to be caused in Puerto Rico by species of *Pythium* and *Plasmodiophora*. Matz (8) at the Insular Experiment Station was able to destroy healthy cane roots by inoculations with pure cultures of these fungi, but in the field they are supposed to be facultative, that is, able to attack the cane roots only when injured by soil animals or weakened by adverse soil conditions. Apparently an experiment has never been conducted in Puerto Rico in which all the symptoms which are supposed to be those of root disease have been

produced by inoculations with pure cultures of any fungi under conditions in which the soil animals have been eliminated. When one goes through the work of the early plant pathologists of the Insular Experiment Station, such as Johnston and Stevenson, and of the entomologists such as Van Dine and Van Zwaluwenburg it is very interesting to notice now the former considered fungi the main cause of "root disease" while the latter insisted on the importance of soil animals. Now that we know more about the animals that injure sugar cane roots and of the facultative nature of the fungi which can cause root disease, we realize that possibly the entomologists were nearer to the truth than the plant pathologists. The only experiment conducted in 1920 at the Insular Experiment Station by Matz (8) to prove that fungi could produce the condition known as "root disease" proved on the contrary that there was no difference between his inoculated plants in pots and the checks until they were set out in the fields, harvested at maturity and allowed to ratoon. Then, those of the ratoons that showed stunting, drying out of the leaves, etc., happened to be in "a very compact soil." We can see how root pests whose injury may become the limiting factor in compact soils might have complicated Matz's experiment since no precautions were taken to eliminate them. Matz himself admits that: "This unevenness was no doubt due to soil conditions, as the effect of the previous inoculations were entirely lost during the first season of growth after the transplanting to a new location."

The Possibilities for the Control of the Root-Caterpillar

Soil fumigants

Wolcott (15, 16) has investigated the use of paradichlorobenzene, calcium cyanide and the carbon bisulphide fish oil emulsion recommended by Leach and Thompson for the Japanese beetle, for the control of white grubs in Puerto Rico and found that the first two fumigants kill only a low percentage of grubs and are quite expensive. The bisulphide emulsion kills a high percentage but its cost is also prohibitive and the mode of application by means of a hose or some such arrangement is impractical.

We have made several tests with the carbon bisulphide emulsion. In metal drums it gave an almost complete control of all root pests when applied to the moist soil at the rate of 6cc of the diluted emulsion per square foot of soil. The only possibility of using it would be in cane under irrigation by applying the fumigant with the irrigation water, but it is questionable if this would be practical.

According to Jarvis (6) paradichlorobenzene and carbon bisulphide are used in routine field practice in Queensland for the control of white grubs. We have tested these two fumigants in cane fields on the Station grounds making the applications in the manner and using the largest doses recommended for Queensland attempting to kill all root pests found in Puerto Rican soils, but with complete failure. The soils to which the fumigants were applied may be considered representative of the average on the Island. At different intervals up to two weeks after the applications were made, perfectly healthy white grubs, root caterpillars, Symphylids and bristle-tails were to be found within six inches from the points of application. The fumigants do not diffuse as readily through the soils of Puerto Rico as they do through the soils in Queensland. We have not tested calcium cyanide, but it will also be difficult for this fumigant to diffuse through the hard packed soils.

CULTUREL PRACTICES

Starting from the point that sugar cane will produce satisfactory yields when the soil conditions are favorable even in spite of the injury caused by root pests, it logically follows that when the soil conditions are unfavorable they must be corrected before any other measure of direct control can be contemplated. In all the work of the late Professor Earle on "root disease" (1) and sugar cane culture (2) we find constant reference to the need of keeping the soil in cane fields loose and permeable. When we go through the history of the sugar cane industry in Puerto Rico we find that the loss of organic matter and the resulting bad physical and chemical condition of the soils has been a constant source of trouble, and that the condition we know as "root disease", "root disease complex" or "growth failure complex" is nothing new.

In the beginning, all that was necessary was to make a hole in the virgin soil, plant the seed pieces of the "Criolla" or "Otaheiti" cane and keep down the weeds with the hoe to get crop after crop from the same planting. But gradually, the organic matter content of the soil decreased and in 1872 we hear of an epidemic, a "disease" of the cane plant in which isolated stools or patches throughout the plantations, dried out and died. We have careful reports published at that time of the symptoms and they are exactly those of root injury that we have been discussing or those that Earle gives for "root disease." We have also very careful reports of the observa-

tions and the experiments made at that time to determine the possible cause of the trouble. We known that although a few white grubs were observed, they were not abundant enough to be considered the cause. It is also recorded that sections of the stalk taken up into the mountains and planted where no cane had grown produced normal plants and that sections from their stalks when taken back again to the original soil produced "diseased" plants. The conclusion logically reached at that time was that the origin of the trouble was in the soil and not in the cane plant and it was noted that for some reason the root system of the cane varieties grown—the "Criolla" or "Otaheiti" which once produced good yields were no longer suitable for the soil

The cane had not changed, but the soils had. They had lost much of their organic matter. Due to their high organic matter content, the virgin soils were rich, porous and retentive of moisture. In them the "Otaheiti" cane with its shallow and weak root system could find sufficient food and could make up by a constant production of new roots the damage caused by soil animals. As the soil began to loose its good chemical and physical conditions the cane began to suffer. It was not until 1872, however, that the trouble was felt when it became so abundant as to affect the sugar cane industry of the whole Island.

Apparently the situation was remedied for some time by the introduction of new Oriental cane varieties with stronger and deeper root systems. In 1910, when the Insular Experiment Station was established, the first plant pathologists and entomologists immediately focused their attention on the "root disease" of sugar cane as of fundamental importance. With the introduction of sugar cane mosaic disease into Puerto Rico, from 1915 to 1919, the center of interest changed to the new disease, but with mosaic under control, by 1919, the investigational interest goes back again to "root disease." Earle (1) wrote in 1920, as follows:

"This trouble is always with us. There is not a cane field in the Island that is not more or less affected by it. It is the cause of the dying out of the cane in so many fields that necessitates such frequent replantings. If it were not for root disease we would be to-day cutting twenty or thirty ratoon crops from each planting of cane as was done in the early days of the cane industry of this Island, and is still being done on virgin lands in eastern Cuba and in Santo Domingo. The expense of these frequent replantings is by no means the only loss caused by root disease. It is safe to say that one form or another of the troubles known under this collective name is causing a loss

of tonnage on every acre of cane now growing in Porto Rico. Few cane planters who really understand these facts will question the statements that this is by far the most serious problem that confronts the cane grower not only in Porto Rico but on old lands in all parts of the sugar cane growing world.''.

Earle condemns the practice of planting cane in holes as in the early days of the industry and recommends the destruction of weeds through cultivation instead of the hoe, to keep the soil in good tilth and save moisture. He compares the growing of sugar cane, a crop requiring enormous amounts of water during all its life, and without cultivation in the most compact of soils as done in Puerto Rico, with the growing of cotton, a plant which does not require much water and for a short period only, with cultivation in loose soils in the United States. We can not take up all the recommendations made by Earle (2) intended for keeping the soil loose and moist and inducing a vigorous, abundant and deep root system, but we can quote the more important ones:

''Used with good judgment, proper drainage, abundant fertilizer and frequent tillage will prevent nineteen-twentieths; yes, ninety-nine hundredths of the cases of 'root disease' and at the same time will so increase yields that they will prove a decided economy and not an expense.''

We might add that if the dead leaves were removed from the stalks and the trash buried if possible during cultivation, the moths of the root-caterpillar would be deprived of cover. This would tend to restore the organic matter and produce the conditions under which the plants can make up for the damage caused by the insect. Frequent cultivation might also reduce the insect by destroying many of the pupæ and some of the caterpillars. If to this were added the growing of legumes to be plowed under instead of allowing the land to lie fallow and the cane stubble to die out gradually to be replaced by grasses, this would further increase the fertility, and organic matter, and help to control the root-caterpillar, other soil animals and the grasses.

If Earle's recommendations are desirable to control or prevent root desiase, now that we know how the root caterpillar and other new root pests work and affect the sugar cane plant, the same recommendations should be even more desirable. We may, through breeding and selection produce cane varieties with deeper and stronger root systems as Venkatram and Thomas (18) recommend and indeed this is very advisable, but we should first of all correct the soil con-

ditions keeping in mind another of the recommendations made by these authors, namely that: *"To get a good crop the sugar cane should be given facilities for the frequent production of new roots."*

Summary

1. A root-boring caterpillar has been found in Puerto Rico in the soil around sugar cane roots which has been named the sugar cane root caterpillar, *Perforadix sacchari* new genus and species (Pyralididæ, Endotrichinæ). It had been previously reported as *Sufetula grumalis* Schaus (Pyralididæ, Pyraustinæ) and specimens under that name from Puerto Rico and Santo Domingo are to be found in the collection of the U. S. National Museum in Washington.

2. In captivity, the larvæ will also feed on the roots of corn, bamboo and *Gynerium sagitattum*, but in nature no indication of the work of this insect has been found on the roots of these plants.

3. In the early instars the caterpillars feed on the very tender roots or in their absence may tunnel in the cortex of the mature roots of sugar cane. The later instar caterpillars tunnel in the thick succulent tips of the tender roots.

4. The damage is cumulative. As the plantation grows older the number of caterpillars and the amount of injury increases. The injury may not show above ground but probably it causes always some reduction in yield and shortens the duration of the plantation. Upon the advent of dry weather and when the soil conditions are unfavorable for the production of new roots, the destruction of the root-tips may become in some localities the limiting factor in sugar cane growing.

5. The distribution of the caterpillars is not uniform in any plantation, and furthermore they seem to migrate from one plant to another in search of fresh root tips. As the soil also varies within any particular field, the root injury showing in the parts of the plant above ground, is not uniform. Scattered stools or patches of stools will dry out while the rest of the plantation may be uniformly green.

6. As a rule, when the soil conditions are proper for the sugar cane plant, although the injury to the roots may be abundant, it does not show above ground.

7. The root injuries produced by the younger caterpillars may be confused with those produced by other soil animals, but the tunneling in the larger roots made by the older caterpillars and the piles of whitish excrement thrown out of them are characteristic and unmistakable.

8. Soil fumigants have so far proved impractical, but the cultural practices recommended by Earle for "root disease" would make it possible for the plants to keep up a constant production of new roots and to produce satisfactory yields in spite of the injury caused by the root caterpillar.

9. Other new root pests of sugar cane whose injuries are found associated with those of the root caterpillar are the Symphylid, *Hanseniella* sp., the bristle-tails, *Nicoletia* and *Lepisma* spp., and the sow bug, *Philoscia culebrae* Moore.

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EXPLANATION OF PLATES

PLATE XX

Fig. 1. Adult female of *P. sacchari* enlarged.

Fig. 2. A, empty pupa cell of *P. sacchari;* B, newly emerged adult; C, empty pupal skin.

Fig. 3. Tunnel of small *P. sacchari* caterpillar extending full length in cortex of root after the epidermis has decayed exposing it; A, side roots with pits made by the Symphylid. *Hanseniella* sp.

Fig. 4. Full-grown *P. sacchari* caterpillar on large sized sugar cane root near entrance of tunnel which is surrounded by piles of excrement.

Fig. 5. The work of the root-caterpillar in sugar cane roots; A, a perfect tunnel with the shell of the root tip held up by silk threads; B, the entrance hole to the tunnel obstructed with pellets of excrement; C, a smaller root whose tip was not as succulent as in A tunneled by a smaller caterpillar; D, a mature root in the cortex of which a small caterpillar has tunneled showing piles of excrement on the side of the root; E, edge of petri dish.

Fig. 6. Same as 4, a different view.
Fig. 7. A good sized sugar cane root whose tip had been destroyed and which had produced side roots. A, entrance hole in tunneled root; B and C, severed roots of which only parts of the base are left attached to the main root; the three round holes in the main root are the work of the Symphylid, *Hanseniella* sp.
Fig. 8. A group of eggs of *P. sacchari* deposited on a cane root that lay on the surface of the ground.

PLATE XXI

Illustrations of work. A, C, D, E, F, G, old injuries; B and H, recent injuries, a, entrance hole of tunnel; b, piles of excrement, c, emptied out region of root tips; d, pits made by the Symphylid *Hanseniella* sp. e, the work of bristle-tails and possibly also sow-bugs.

PLATE XXII

Eggs greatly enlarged. A, C and D, sketches showing grouping as laid; B, E, F and G, eggs as laid singly. E and F lateral views, G, dorsal view.

PLATE XXIII

Fig. 9. Larva, dorsal view.
Fig. 10. Larva, lateral view.

PLATE XXIV

Fig. 11. Seta-map.
Fig. 12. Labrum, greatly enlarged.
Fig. 13. Head and cervical shield, dorsal view.
Fig. 14. Head, cervical shield and pro-thorax, lateral view.

PLATE XXV

Fig. 15. Pupa, dorsal view.
Fig. 16. Pupa, ventral view.
Fig. 17. Pupa, lateral view.

PLATE XXVI

Fig. 18. Fore wing.
Fig. 19. Hind wing.
Fig. 20. Variations in the length of the stalking of R_5 with R_3 and R_4 and origin of veins from cell.

PLATE XXVII

Fig. 21 *a*. *Diplopseustis minima*, head, side view.
Fig. 21 *b*. *Perforadix sacchari*, head, side view.
Fig. 22. *P. sacchari*, head, anterior view, partly denuded with details of antennae and maxillae.

PLATE XXVIII

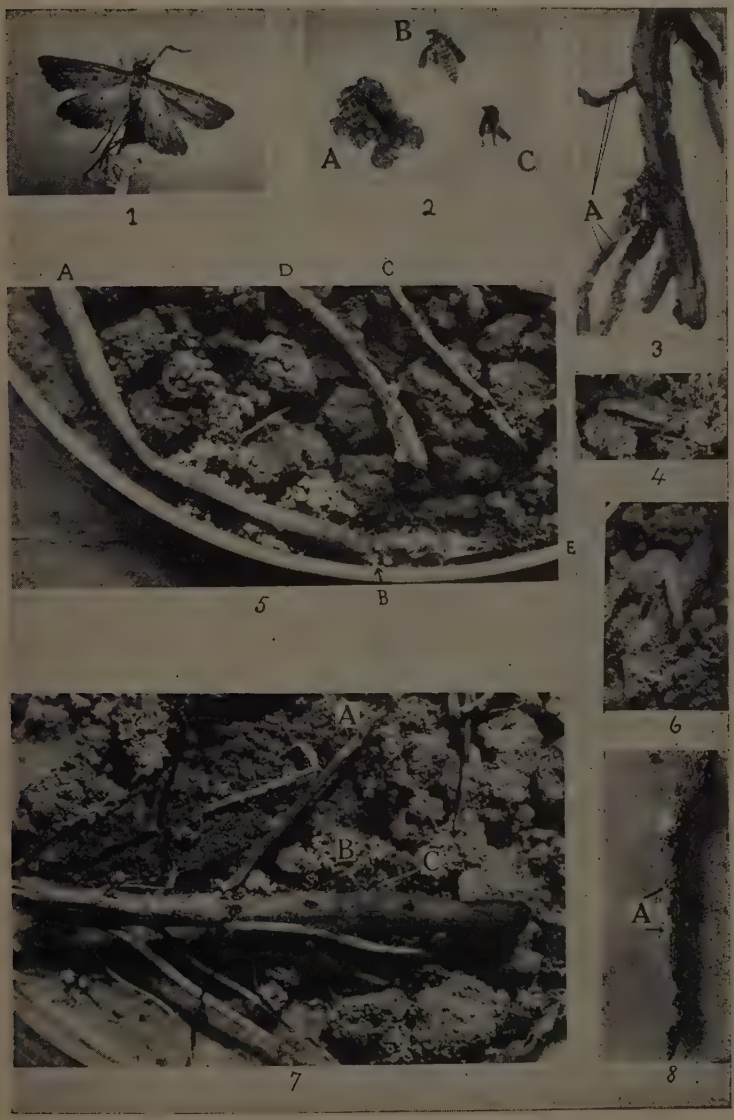
Fig. 23. Fore leg.
Fig. 24. Middle leg.
Fig. 25. Hind leg.
Cl, Claw; Cx, coxa; Ep, epiphysis; F. femur; Pv. pulvillus, Sp, spurs; Tar, tarsus; Tb, tibia; Tr, trochanter.

PLATE XXIX

Fig. 26. Female genitalia, latero-ventral view; Oo. ovipositor; Ov, opening of vagina.
Fig. 27. Tip of ovipositor with egg ready to be laid, dorsal view.
Fig. 28. Male genitalia cut through left valve and opened out.
Fig. 29. Male genitalia, ventral view.
Fig. 30. Inner face of valve, more enlarged.

o–O–o

PLATE XX



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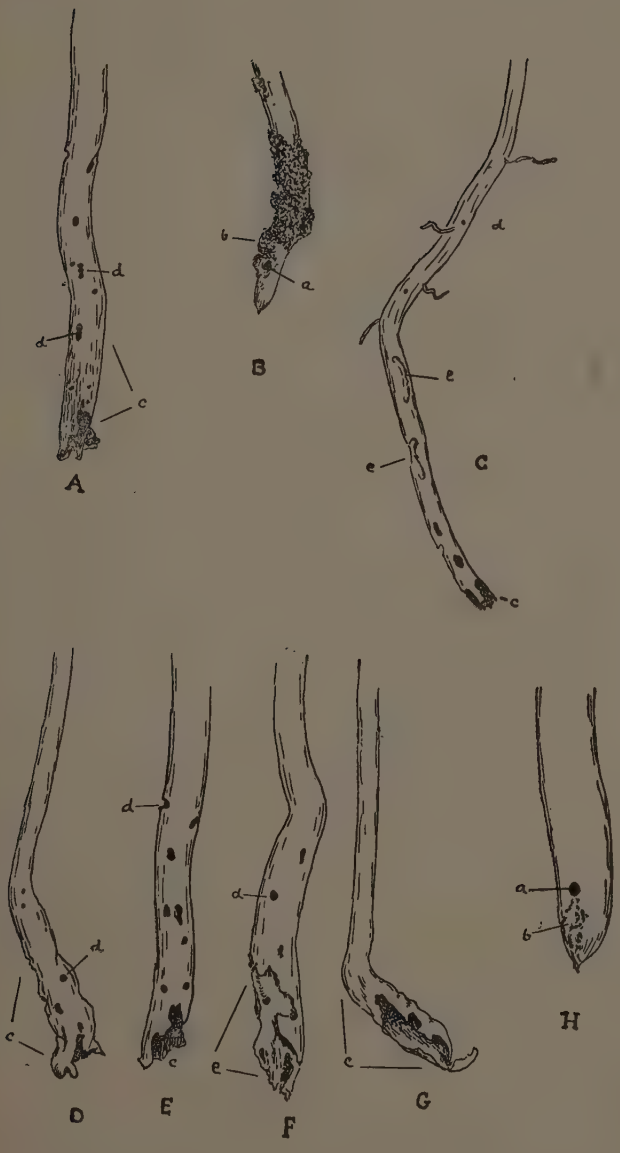

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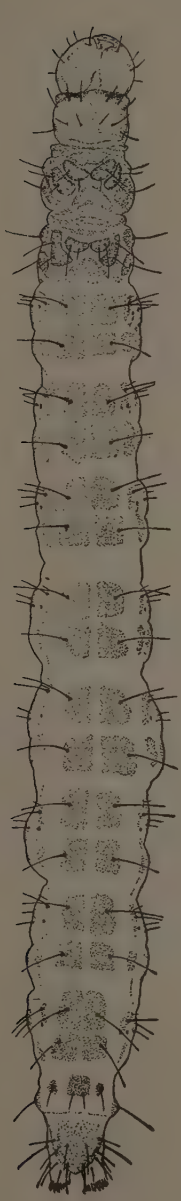

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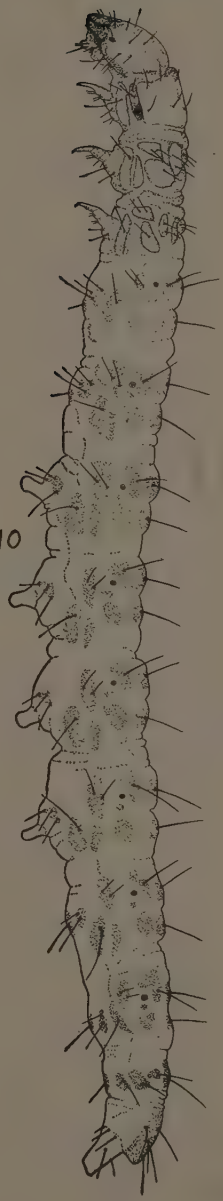

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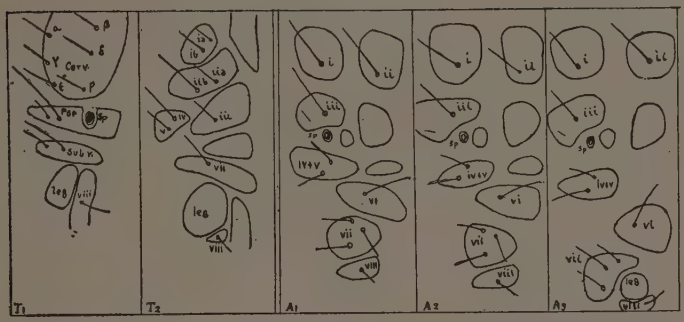

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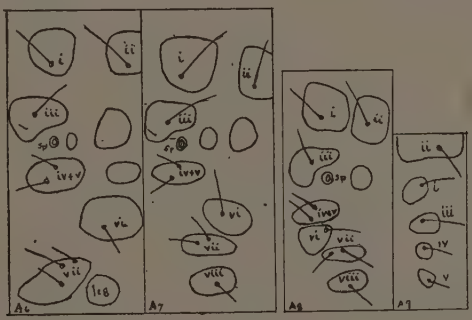

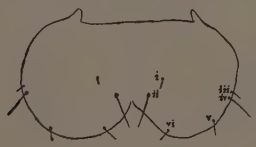

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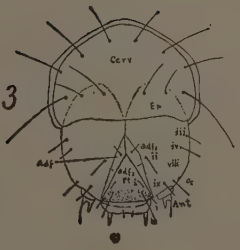

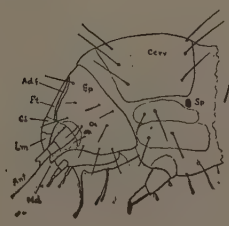

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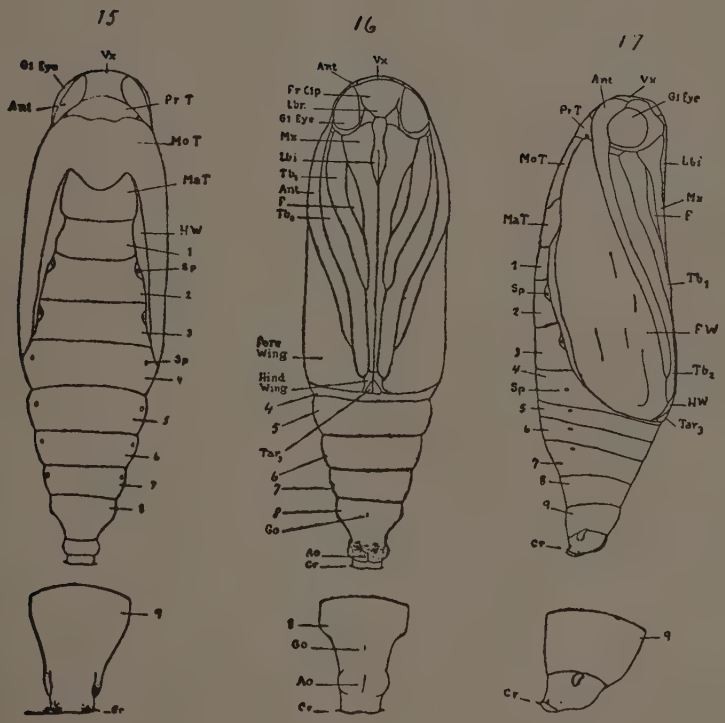
PLATE XXV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Gl Eye
Vx
Ant
Pr T
Mo T
Ma T
HW
1
Sp
2
3
Sp
4
5
6
7
8
9
Cr
16
Ant
Vx
Fr Clp
Lbr
Gl Eye
Mx
Lbi
Tb1
Ant
F
Tb2
Fore Wing
Hind Wing
4
5
Tar3
6
7
8
Go
Ao
Cr
17
Ant
Vx
Gl Eye
Pr T
Mo T
Lbi
Mx
F
Ma T
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Sp
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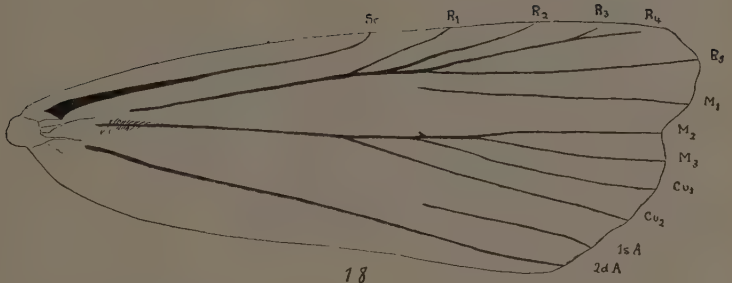
Cr

PLATE XXVI



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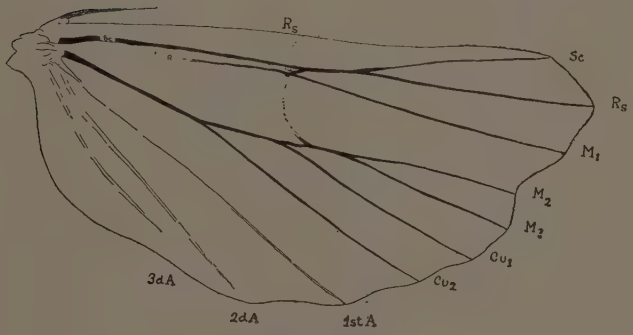

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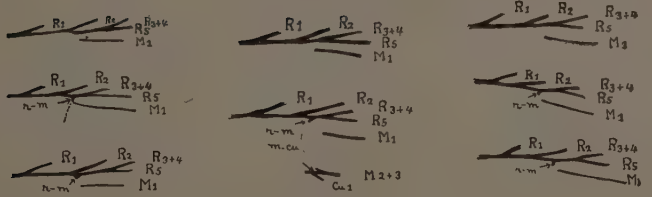

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PLATE XXVII

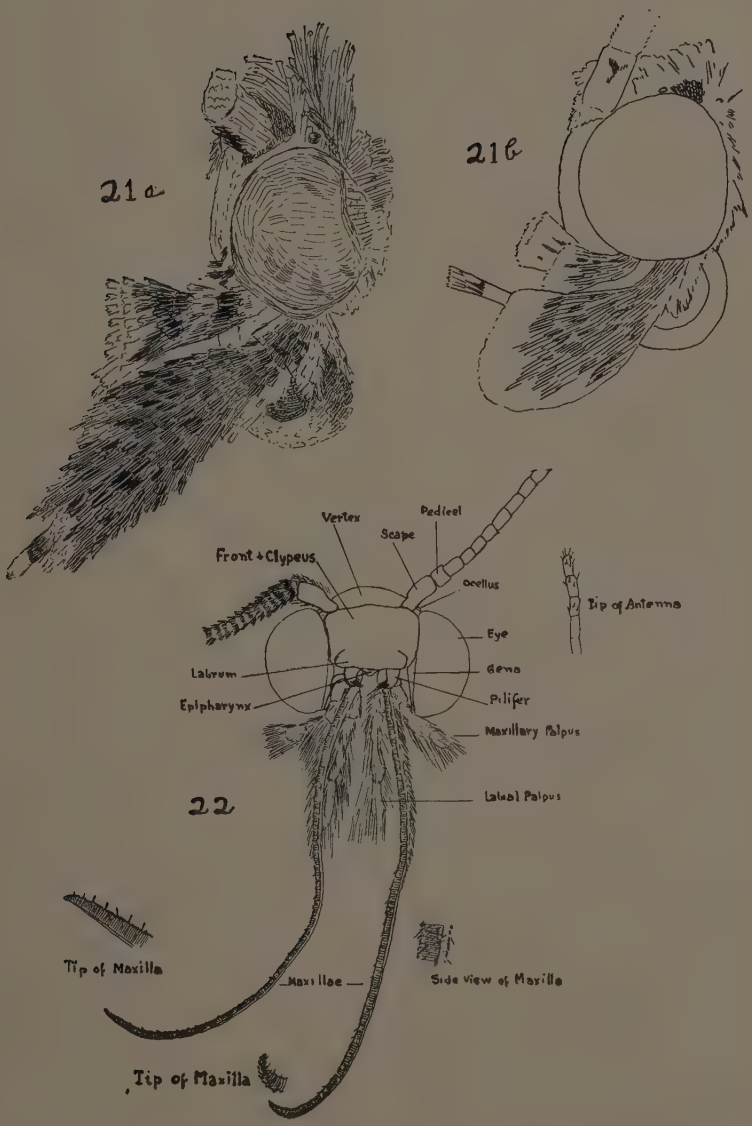

21a
21b
Vertex
Pedicel
Scape
Front + Clypeus
Ocellus
Tip of Antenna
Eye
Labrum
Gena
Epipharynx
Pilifer
Maxillary Palpus
22
Labial Palpus
Tip of Maxilla
Maxillae
Side view of Maxilla
Tip of Maxilla

PLATE XXVIII

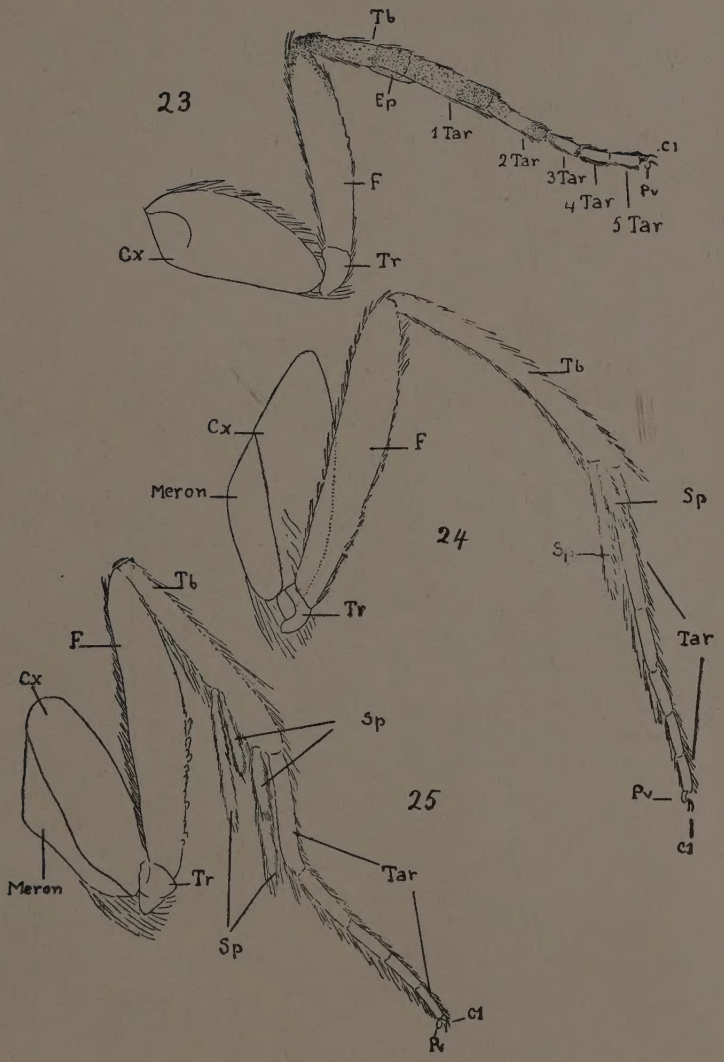
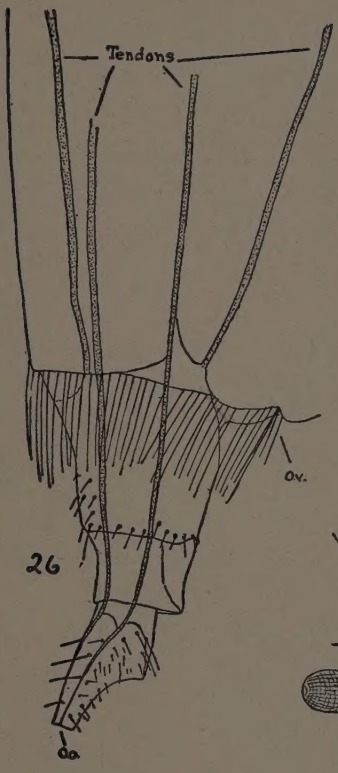


PLATE XXIX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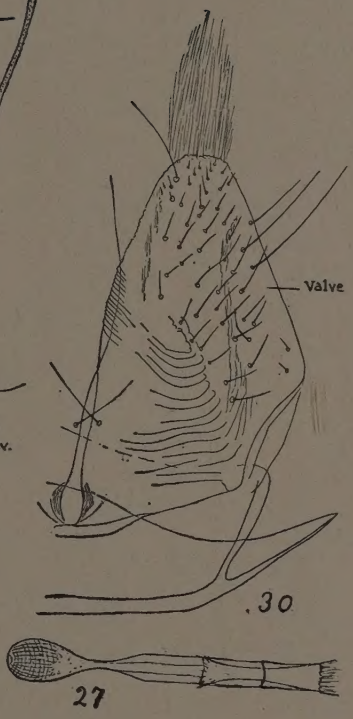
Ov.
26
Od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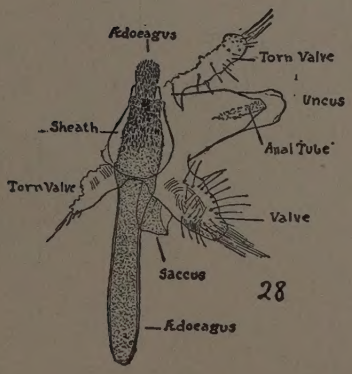
30
27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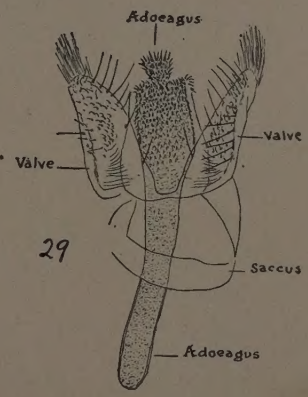
Torn Valve
Uncus
Sheath
Anal Tube
Torn Valve
Valve
Saccus
28
Ædoeagus


Ædoeagus
Valve
Valve
29
Saccus
Ædoeagus